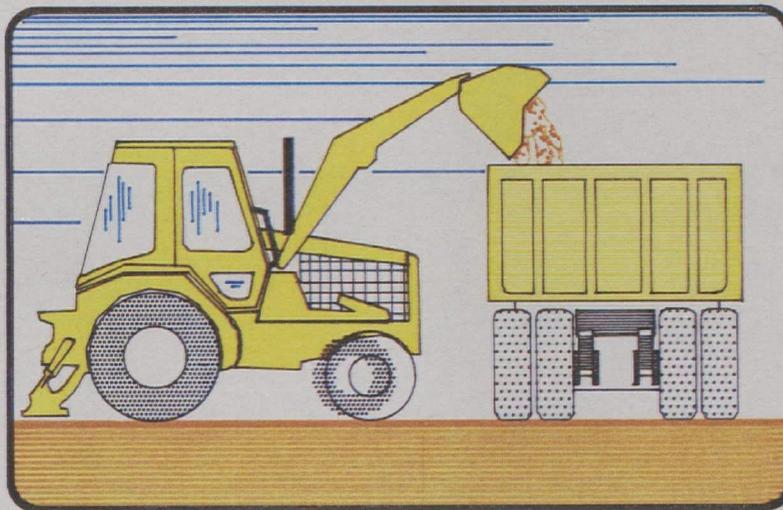


# An Evaluation Of Arsenic, Cadmium, Lead, And Zinc Mobility In East Field Soils

## Focused Feasibility Study On The Location And Method Of Disposal Of East Helena Soils

Draft

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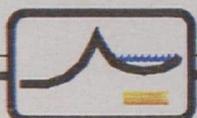
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**March 1993**



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**DRAFT**

**AN EVALUATION OF ARSENIC, CADMIUM, LEAD  
AND ZINC MOBILITY IN EAST FIELD SOILS**

**FOCUSED FEASIBILITY STUDY  
ON THE LOCATION AND METHOD OF DISPOSAL  
OF EAST HELENA SOILS**

**- DRAFT -**

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## EXECUTIVE SUMMARY

Soil samples were collected from deep soil test pits for the purpose of evaluating the vertical extent of arsenic, cadmium, lead and zinc migration in the East Field soils and the characteristics of natural soil layers that would influence the migration of arsenic and metals. The Hydrologic Evaluation of Landfill Performance model was used to simulate the climatological conditions and determine the potential for soil water to percolate to the groundwater system. Regression analysis was used to determine the correlation between total soil arsenic and metals concentration and soil depth for the soil samples collected from the East Field.

It was concluded that arsenic, cadmium, lead and zinc have not migrated below a depth of two feet in the native East Field soils. There was a strong negative correlation between total soil concentrations of arsenic, lead and zinc and soil depth in the East Field. This was attributed to natural clay and carbonate soil horizons in East Fields soils which effectively attenuate arsenic and metals. According to HELP model simulation results, there is little or no potential for soil water that percolates from the surface to reach the groundwater system. Accordingly, there is little or no potential for arsenic and metals which are bound in the surface layers of the East Field soils to reach the groundwater system. The addition of a 1-foot thick East Helena residential soil cap further reduces the potential for soil water, arsenic and metals, to percolate to the groundwater system.

# **AN EVALUATION OF ARSENIC, CADMIUM, LEAD AND ZINC MOBILITY IN EAST FIELD SOILS**

## **FOCUSED FEASIBILITY STUDY ON THE LOCATION AND METHOD OF DISPOSAL OF EAST HELENA SOILS**

**- DRAFT -**

### **1.0 INTRODUCTION**

Soil descriptions provide useful information on the morphological, physical and chemical characteristics of soils that, in the case of the East Field, influence the mobility of arsenic and metals and can be used to evaluate the feasibility of specific remediation alternatives. The alternatives that are the focus of soil survey interpretation in the East Field include the application of a residential soil cap and/or the treatment of East Field soils with applications of lime and tillage. In particular, the characteristics of the native soils in the East Field can be used to evaluate the potential for downward migration of arsenic and metals with percolating rain water.

The objective of this study was to determine the present vertical extent of arsenic, cadmium, lead and zinc migration, to validate soil survey information, and to develop input for a hydrologic evaluation of the performance of a residential soil cap with respect to the potential for leachate and the migration of arsenic and metals to the groundwater system. These evaluations will support the selection of appropriate alternatives for the disposal of East Helena residential soils.

## **2.0 METHODS AND MATERIALS**

### **2.1 DEEP SOIL TEST PITS AND SOIL SURVEY VERIFICATION**

Five deep soil test pits were excavated with a backhoe to a depth of six feet. Utilizing the Soil Survey of The Helena Valley (USDA SCS date unknown) with coverage of the Focused FS study area, two of the deep pits were located in the Nippt series, two in the Attewan series and one in what was originally considered the Amesh series. Samples were collected from the highwall of the deep pits from 0-4 inch, 4-8 inch, 8-15 inch, 15-30 inch, 30-45 inch and 45-60 inch depth increments. The samples were shipped to the Asarco Technical Services Center (TSC) laboratory in Salt Lake City, Utah and analyzed for total, plant available, and water soluble arsenic, cadmium, lead and zinc; pH; cation exchange capacity; electrical conductivity; organic matter; texture; and carbonates according to procedures outlined in the Focused FS work plan (Hydrometrics, Inc. 1992). With the assistance of USDA SCS personnel, a detailed profile description of each pit was prepared and used to verify that the pit was representative of the intended series. The Nippt and Attewan series were verified, but the Amesh series was reclassified as the Evanston series. The location of the deep backhoe pits and a soil survey map of the study area are in Figure 1. The results of the analysis of samples collected from each of the deep test pits are in Tables 1a and 1b. Soil profile descriptions are in Table 2.

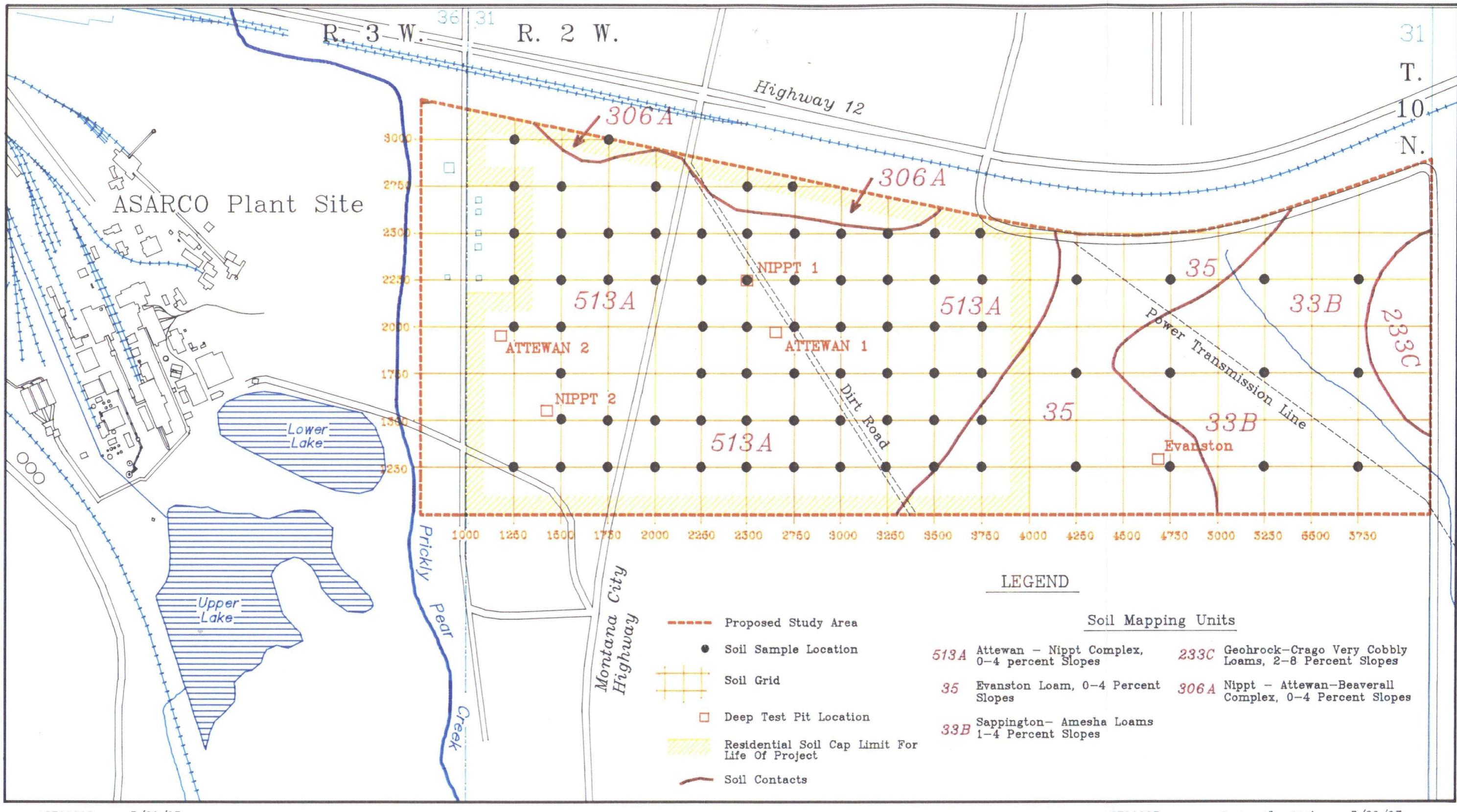


Figure 1.  
Soil Survey Of Study Area  
And Location Of Deep Test Pits

Table 1a Soil Chemical Characteristics of Deep Soil Test Pits in the East Field

Soil Series	Sample Depth (in)	pH	Sat %	EC (mmhos/cm)	CEC (meq/100g)	Sand (%)	Silt (%)	Clay (%)	OM (%)	CaCO <sub>3</sub> (%)
Attewan 1	0-4	6	24.4	0.75	21.64	55	34	11	2.6	0.5
	4-8	5.7	32.2	0.7	22.42	55	36	9	1	0.3
	8-15	7.5	45.2	0.61	32.07	33	48	19	1.4	5.7
	15-30	7.8	38.8	1.06	24.11	11	56	13	2.4	15.5
	30-45	7.8	20.4	2.1	10.32	73	24	3	0.3	4
	45-60	7.9	23.5	1.5	7.27	89	10	1	0.3	0.1
Attewan 2	0-4	7	36.2	0.6	26.85	49	41	10	3.8	0.6
	4-8	7.2	35.6	0.55	26.85	49	39	12	3.2	0.7
	8-15	7.5	36.2	0.92	23.46	41	42	17	1.4	13.9
	15-30	7.5	31.1	2.01	13.95	55	35	10	0.7	9.6
	30-45	7.6	27.8	3.01	10.52	65	31	4	0.3	4
	45-60	7.9	23.1	1.59	6.53	89	9	2	0.2	0.3
Nippt 1	0-4	5.8	22.6	0.63	15.64	61	34	5	1.4	0.1
	4-8	6.8	24.1	0.46	10.95	84	11	5	0.7	0.2
	8-15	7.5	22.2	0.54	9.91	85	14	1	0.5	0.3
	15-30	8	22.3	0.43	18.38	91	9	0	1.2	0.5
	30-45	8.1	23.7	0.59	16.29	93	7	0	0.2	0.1
	45-60	8.2	24.7	0.32	6.8	93	7	0	0.3	0.1
Nippt 2	0-4	5.5	23.5	2.44	22.29	53	38	9	1.4	0.1
	4-8	5.5	38.2	1.67	33.24	41	40	19	1.4	0.1
	8-15	7.4	23.1	0.81	11.86	83	17	0	0.9	2.7
	15-30	8	26.1	0.41	4.93	95	5	0	0.2	0.8
	30-45	8.1	23.1	0.48	7.43	91	7	2	0.2	0.3
	45-60	8.2	20.2	0.67	8.37	89	9	2	0.2	0.2
Evanston	0-4	5.7	30.4	0.37	25.42	43	45	12	2.4	0.1
	4-8	5.5	31.6	0.32	26.33	41	51	8	1.7	0.5
	8-15	6.6	32.1	0.31	26.46	46	43	11	1.2	1
	15-30	7.3	36.2	0.46	25.94	49	45	6	1.2	1.8
	30-45	7.4	29.6	2.25	23.59	43	49	8	0.7	4.1
	45-60	7.4	31	2.54	21.77	49	44	7	0.9	4.1

Sat % = saturation percentage

EC = electrical conductivity

CEC = cation exchange capacity

OM = organic matter

Table 1b Deep Soil Test Pit Arsenic and Metals Concentrations for Three Extraction Procedures

Soil Series	Sample Depth (in)	ARSENIC			CADMIUM			LEAD			ZINC		
		Extraction Type			Extraction Type			Extraction Type			Extraction Type		
		HF (Total) (mg/kg)	NH4F/HCl (mg/kg)	Paste (mg/kg)	HF (Total) (mg/kg)	DTPA (mg/kg)	Paste (mg/kg)	HF (Total) (mg/kg)	DTPA (mg/kg)	Paste (mg/kg)	HF (Total) (mg/kg)	DTPA (mg/kg)	Paste (mg/kg)
Attewan 1	0-4	140	31	0.2	25	12	0.53	820	970	0.1	360	78	3.9
	4-8	150	13	0.2	23	19	0.23	870	425	0.1	360	100	0.2
	8-15	51	3.5	0.2	17	7.2	0.1	58	5.7	0.1	170	12	0.2
	15-30	30	3.5	0.2	1	0.26	0.1	61	11	0.1	90	1.3	0.2
	30-45	30	3.5	0.2	0.5	0.02	0.1	43	0.74	0.1	60	0.05	0.2
	45-60	30	3.5	0.2	0.5	0.02	0.1	31	0.4	0.1	41	0.05	0.2
Attewan 2	0-4	260	34	0.2	150	69	0.1	3850	231	0.1	2220	418	1.3
	4-8	160	14	0.2	49	26	0.1	1860	461	0.1	930	200	0.2
	8-15	130	3.5	1.7	3	0.5	0.1	155	17	0.1	140	5.3	0.2
	15-30	84	3.5	0.1	1	0.02	0.1	43	1.3	0.1	101	0.3	0.2
	30-45	30	3.5	0.1	1	0.02	0.1	54	2	0.1	106	0.24	0.2
	45-60	30	3.5	0.1	0.5	0.02	0.1	30	0.26	0.1	45	0.05	0.2
Nippt 1	0-4	200	25	0.2	21	13	0.59	1460	768	0.1	380	93	4.7
	4-8	94	3.5	0.2	25	9.7	0.1	74	12	0.1	390	87	0.2
	8-15	30	3.5	0.2	2	0.7	0.1	44	5.8	0.1	94	4.7	0.2
	15-30	27	3.5	0.2	1	0.06	0.1	24	0.68	0.1	38	0.24	0.2
	30-45	32	3.5	0.2	0.5	0.02	0.1	21	0.02	0.1	31	0.02	0.2
	45-60	30	3.5	0.2	1	0.02	0.1	30	0.2	0.1	33	0.05	0.2
Nippt 2	0-4	450	72	0.2	56	26	11	4600	726	3.7	1005	150	96
	4-8	210	15	0.2	66	49	4.8	1540	245	0.81	800	248	36
	8-15	60	3.5	0.2	33	16	0.1	41	3.2	0.1	320	81	0.2
	15-30	30	3.5	0.2	0.5	0.04	0.1	33	0.52	0.1	43	0.64	0.2
	30-45	30	3.5	0.2	0.5	0.02	0.1	40	0.42	0.1	48	0.05	0.2
	45-60	30	3.5	0.2	0.5	0.02	0.1	34	0.2	0.1	50	0.05	0.2
Evanston	0-4	150	24	0.2	10	6.9	0.1	1170	759	0.1	290	41	0.96
	4-8	65	9.2	0.2	31	19	0.1	360	303	0.1	250	44	0.2
	8-15	30	3.5	0.2	1	0.36	0.1	34	2.1	0.1	77	0.66	0.2
	15-30	22	3.5	0.2	0.5	0.02	0.1	31	1.2	0.1	74	0.05	0.2
	30-45	37	3.5	0.2	1	0.02	0.1	35	1.5	0.1	85	0.1	0.2
	45-60	33	3.5	0.2	0.5	0.02	0.1	32	2.2	0.1	67	0.18	0.2

HF = hydrofluoric acid extraction

NH4F/HCl = ammonium fluoride/hydrochloric acid extraction

DTPA = diethylenetriaminepentaacetic acid extraction

Paste = saturated paste extract

TABLE 2 PROFILE DESCRIPTIONS FOR EAST FIELD DEEP TEST PITS

Attewan Series - fine loamy over sandy or sandy skeletal, mixed Aridic Argiboralls

	Pit 1	Pit 2	
AP	0-6 inches	0-5 inches	Brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure parting to weak very fine granular: soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; slightly acid; abrupt smooth boundry.
Bt	6-10 inches	5-8 inches	Brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; hard friable; sticky and slightly plastic; common very fine roots; many very fine tubular pores; many distinct clay films on faces of peds; 5 percent pebbles; neutral; gradual smooth boundry.
Bk1	10-19 inches	8-17 inches	Very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 12 percent pebbles; disseminated lime; continuous faint lime casts on underside of fragments; violently effervescent; mildly alkaline; clear smooth boundry.
Bk2	19-29 inches	17-30 inches	Brownish yellow (10YR 6/6) very gravelly loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots in the upper part and many fine roots in the lower part; 45 percent pebbles; continuous faint lime casts on undersides of pebbles; violently effervescent; mildly alkaline; clear smooth boundry.
2C	29-60 inches	30-60 inches	Light yellowish brown (10YR 6/4) extremely gravelly sand, dark yellowish brown (10YR 4/4) moist; single grain; loose, nonsticky and nonplastic; 50 percent pebbles and 15 percent cobbles; continuous faint lime casts on the underside of course fragments in upper few inches; slight efferv.

TABLE 2 (Continued) PROFILE DESCRIPTIONS FOR EAST FIELD DEEP TEST PITS

Nippt Series - sandy skeletal, mixed Borollic Haplargids

	Pit 1	Pit 2	
E	0-4 inches	0-3 inches	Light brownish gray (10YR 6/2) gravelly loam, dark brown (10YR 4/3) moist; moderate very thin platy structure; very hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine vesicular pores; 15 percent pebbles; mildly alkaline; clear smooth boundary.
Bt	4-14 inches	3-9 inches	Brown (10YR 5/3) gravelly clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure; hard, friable, sticky and plastic; common very fine and fine roots; many very fine tubular and interstitial pores; 15 percent pebbles; mildly alkaline; clear smooth boundary.
Bk1	14-21 inches	9-17 inches	Light gray (10YR 7/2) extremely gravelly sandy loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; continuous distinct lime casts on undersides of pebbles; 60 percent pebbles; violently effervescent; moderately alkaline; clear smooth boundary.
2Bk2	21-60 inches	17-35 inches	Light gray (10YR 7/2) extremely gravelly sand, dark brown (10YR 4/3) moist; single grain; loose, nonsticky and nonplastic; common fine and very fine roots; continuous faint lime casts on undersides of pebbles; 65 percent pebbles; strongly effervescent; strongly alkaline.

TABLE 2 (Continued) PROFILE DESCRIPTIONS FOR EAST FIELD DEEP TEST PITS

Evanston Series - fine loamy, mixed, Aridic Argiboralls

Pit 1

A	0-5 inches	Grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; soft, very friable, slightly sticky, slightly plastic; neutral; clear smooth boundry.
Bt1	5-13 inches	Brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium prismatic structure that parts to moderate fine subangular blocky; hard, friable, sticky, slightly plastic; few thin patchy clay films on some faces of ped; mildly alkaline; clear smooth boundry.
Bt2	13-27 inches	Yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure that parts to moderate medium subangular blocky; hard, friable, plastic, sticky; thin nearly continuous clay films on the faces of all ped; mildly alkaline; clear smooth boundry.
Btk	27-38 inches	Yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; weak medium prismatic structure that parts to weak medium subangular blocky; hard, friable, sticky, slightly plastic; few thin patchy clay films on ped; calcareous; visible calcium carbonate in the form of soft rounded masses, thin seams, and streaks; moderately alkaline; gradual smooth boundry.
2Bk2	38-50 inches	Light yellowish brown (10YR 5/4) loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, sticky, slightly plastic; approximately 5 percent gravel; calcareous; visible secondary calcium carbonate in the form of soft round masses, thin seams, and streaks; moderately alkaline.
2C	50-60 inches	Light whitish brown (2.5 YR 5/4) silt loam, whitish brown (2.5 YR 4/4) moist; massive; hard, friable, sticky, slightly plastic; calcareous; moderately alkaline.

## **2.2 HYDROLOGIC PERFORMANCE MODELING**

The Hydrologic Evaluation of Landfill Performance (HELP) model (Schroeder, et al, 1988) is a quasi-two-dimensional hydrologic model that accepts climatological, soil, and design data and uses a solution technique that accounts for the affects of surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage and lateral drainage in landfill systems. The HELP model was used to estimate potential percolation to the ground water system under existing soil conditions in the East Field and with the addition of a residential soil cap. The residential soil cap is assumed to cover a 124-acre area of the East Field (Figure 1) one foot deep. The HELP model was used in a similar application to evaluate soil capping scenarios and groundwater impacts at a smelter remediation site in Tacoma, Washington (Hydrometrics, 1993a).

### **2.2.1 Climatological Input**

To simulate climatological conditions at the smelter site, 20 years of historic daily precipitation and temperature data from the Helena airport and synthetically generated daily solar radiation data for Helena, Montana were used as model inputs. Evaporative zone depths and SCS runoff curve numbers were varied appropriately for existing or capped scenarios.

### **2.2.2 Soil Input and Design Parameters**

The soil characteristics or parameters required as model input for each layer included in the existing or soil cap scenario were obtained from deep pit profile descriptions and soil analysis results (Tables 1a, 1b and 2), geologic logs and aquifer test data collected

in conjunction with the East Helena Comprehensive RI/FS (Hydrometrics, 1990) or estimated from established values for materials defined in HELP model documentation (Schroeder et al, 1988). The depth to the groundwater system or the nearest saturated zone is 18 feet.

To account for the differences that Attewan and Nippt soils might have on water budget components simulated in the model, a weighted average approach was used to calculate runoff, evapotranspiration, and percolation for the 124-acre area for the existing conditions and with the addition of a residential soil cap. It was assumed that the 124-acre area consists of 65 percent Attewan-like soils and 35 percent Nippt-like soils and these percentages were used for the weighted average calculations. The soil characteristics used to model existing or soil cap scenarios for individual layers are summarized in Table 3.

### **2.3 EVALUATION OF ARSENIC AND METALS MOBILITY**

Total soil concentrations of arsenic, cadmium, lead and zinc were previously defined for the surface 15 inches (0-4 inches, 4-8 inches and 8-15 inches) of the study area (Hydrometrics, 1993b) based on XRF analyses of samples collected from grid coordinates. The location of grid coordinate samples is in Figure 1. These soil samples were collected to examine the spatial distribution of arsenic and metals in the East Field and the relationship of soil depth versus concentration.

Table 3 Soil and HELP Modeling Parameters for East Field Soils and Residential Soil Cap

RESIDENTIAL SOIL

Layer ID	Layer Type	Thickness (feet)	Texture	Porosity (% by vol)	Field Capacity (% by vol)	Wilting Point (% by vol)	Sat. K (cm/s)	Initial Moisture (% by vol)
Residenti Soil Cap	vertical percolation	1.00	loamy sand	45.3	19.0	8.5	0.0007200	8.5

ATTEWAN SERIES/ALLUVIAL OUTWASH

Layer ID	Layer Type	Thickness (feet)	Texture	Porosity (% by vol)	Field Capacity (% by vol)	Wilting Point (% by vol)	Sat. K (cm/s)	Initial Moisture (% by vol)
AP Horizon	percolation	0.33	loam	46.3	23.2	11.6	0.0003700	17.0
Bt Horizon	vertical percolation	0.33	clay loam	46.4	31.0	18.7	0.0000640	25.0
Bk1 Horizon	vertical percolation	0.58	loam	46.3	23.2	11.6	0.0003700	17.0
Bk2 Horizon	vertical percolation	1.25	loamy sand	45.3	19.0	8.5	0.0007200	8.5
C Horizon	vertical percolation	2.5	sand	43.7	6.2	2.4	0.0058	2.4
Alluvial Outwash	vertical percolation	13	loamy sand	43.7	10.5	4.7	0.00017	4.7

NIPPT SERIES/ALLUVIAL OUTWASH

Layer ID	Layer Type	Thickness (feet)	Texture	Porosity (% by vol)	Field Capacity (% by vol)	Wilting Point (% by vol)	Sat. K (cm/s)	Initial Moisture (% by vol)
Residenti Soil Cap	vertical percolation	1.00	loamy sand	45.3	19.0	8.5	0.0007200	8.5
E Horizon	vertical percolation	0.33	loam	46.3	23.2	11.6	0.0003700	17.0
Bt Horizon	vertical percolation	0.33	clay loam	46.4	31.0	18.7	0.0000640	25.0
Bk1 Horizon	vertical percolation	0.58	loamy sand	43.7	10.5	4.7	0.0017000	7.5
Bk2 Horizon	vertical percolation	3.75	sand	43.7	6.2	2.4	0.0058000	2.4
Alluvial Outwash	vertical percolation	13	loamy sand	43.7	10.5	4.7	0.00017	4.7

Grid coordinate samples and samples from the deep test pits were used to examine arsenic and metals concentrations at depth. The arsenic and metals concentrations in the East Field vary with depth and also with distance from the smelter. To reduce the variation in the data due to distance, all total soil arsenic and metals data were normalized (transformed) by expressing concentrations at each depth interval as a percentage of the concentration in the surface (0 to 4 inch interval) at a given sample location. Regression analysis was conducted on total soil arsenic, lead and zinc to determine their relative mobilities in the East Field soils. The soil depths used for regression were the mean depth values (2 inches for the 0-4 inch interval, 6 inches for the 4-8 inch interval, 11.5 inches for the 8-15 inch interval and so on down to a total depth of 60 inches). The transformed data are in Appendix A.

### **3.0 RESULTS AND DISCUSSION**

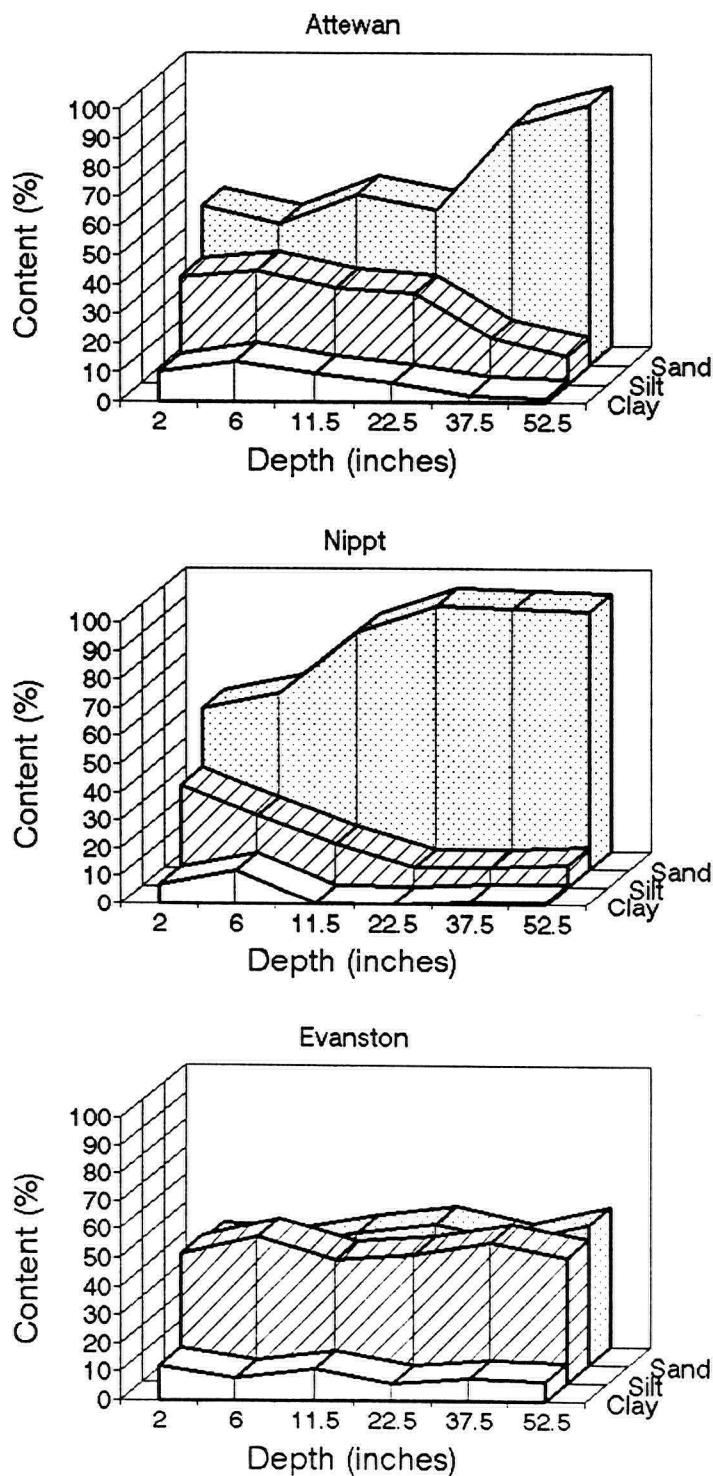
#### **3.1 DEEP SOIL TEST PITS AND SOIL SURVEY**

The soils in the study area (East Field) are formed in Quaternary alluvium from the Prickly Pear Creek drainage. The alluvium consists of layers and mixtures of silt, clay, sand and gravel. The soils of the study area include 127 acres of the Attewan-Nippt complex, 0 to 2 percent slopes, 35 acres of Evanston loam, 0 to 2 percent slopes, 44 acres Sappington-Amesha loams, 1 to 4 percent slopes, 6 acres of Geohrock-Crago very cobbly loams, 2 to 8 percent slopes, and 7 acres of Nippt-Attewan-Beaverell complex, 0 to 4 percent slopes (Figure 1). The portion of the study area proposed to receive a cap of East Helena residential soil is comprised of approximately 60 percent Attewan soils and 33 percent Nippt soils. Profile descriptions of the deep test pits (Table 2) adequately matched typical pedon descriptions published for the Attewan and Nippt series. However, a deep test pit profile description of what was initially identified on the surface as Amesha silt loam was subsequently re-evaluated and changed to an Evanston loam.

The soil chemical and physical characteristics that were measured in the deep pit profiles and considered most likely to influence the mobility or attenuation of arsenic, cadmium, lead and zinc included texture, (clay content in particular), carbonate, and cation exchange capacity. The vertical distribution of sand, silt and clay in Attewan, Nippt and Evanston soils is in Figure 2. The vertical distribution of carbonates for the Attewan, Nippt and Evanston soils is in Figure 3. Cation exchange capacity plotted as a function of depth for Attewan, Nippt and Evanston soils is in Figure 4.

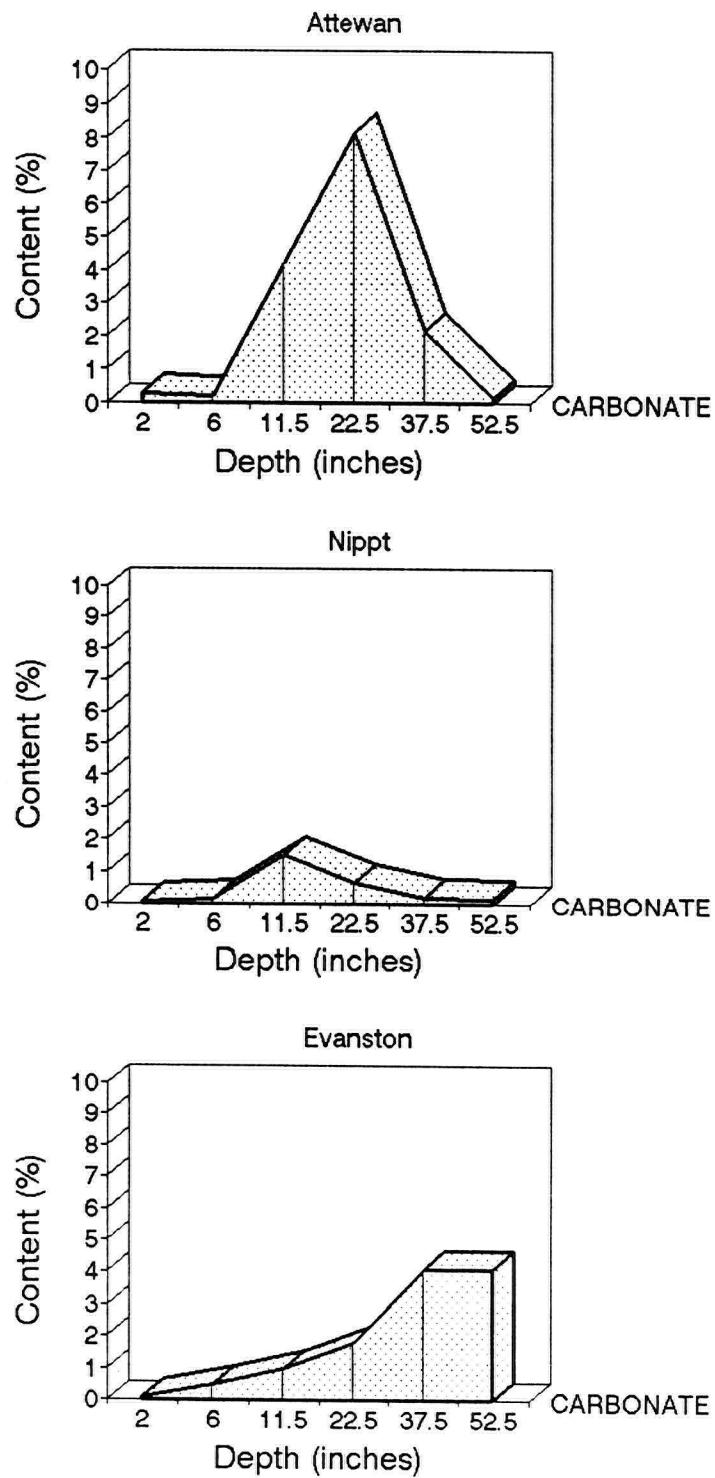
**Figure 2**

VERTICAL DISTRIBUTION OF SAND, SILT, AND CLAY IN ATTEWAN, NIPPT AND EVANSTON SOILS



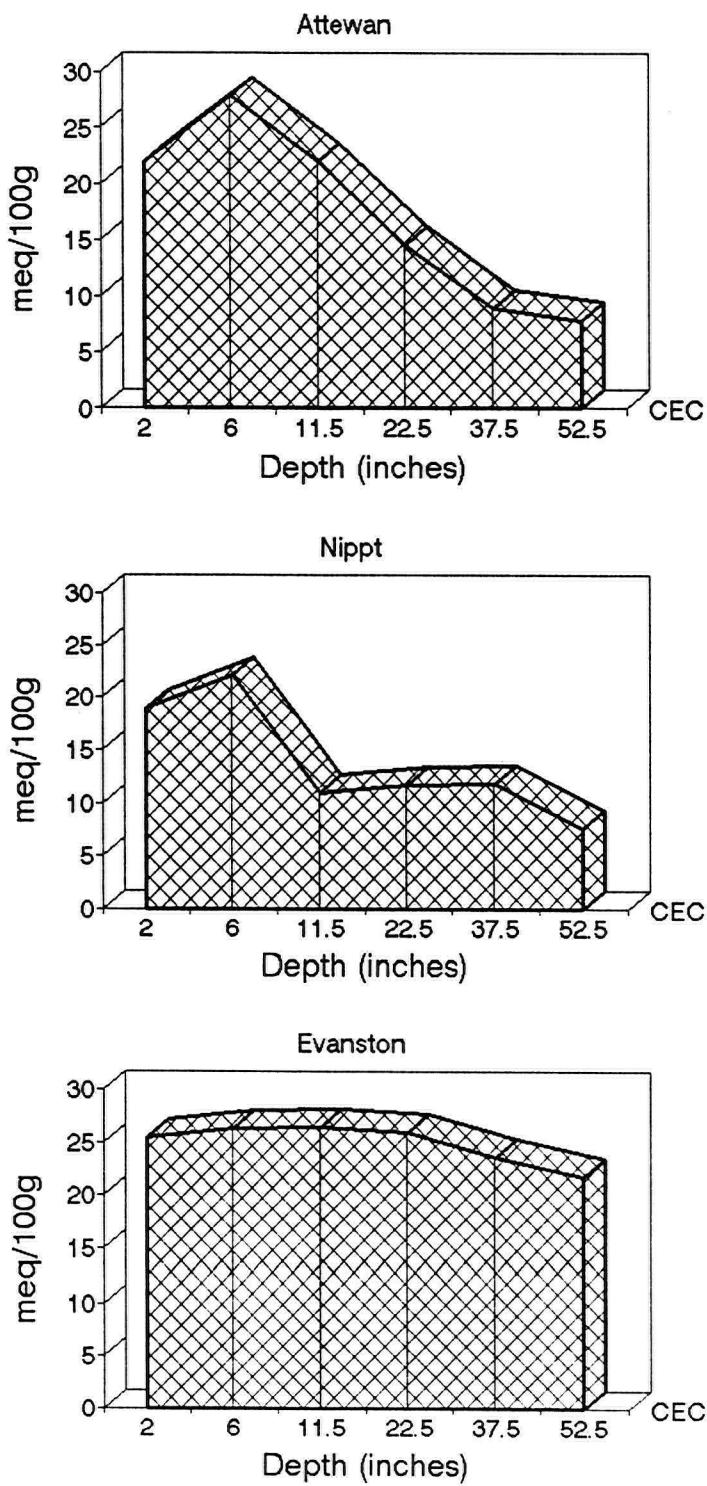
**Figure 3**

VERTICAL DISTRIBUTION OF CARBONATE IN ATTEWAN, NIPPT AND EVANSTON SOILS



**Figure 4**

CATION EXCHANGE CAPACITY AS A FUNCTION OF DEPTH IN ATTEWAN, NIPPT AND EVANSTON SOILS



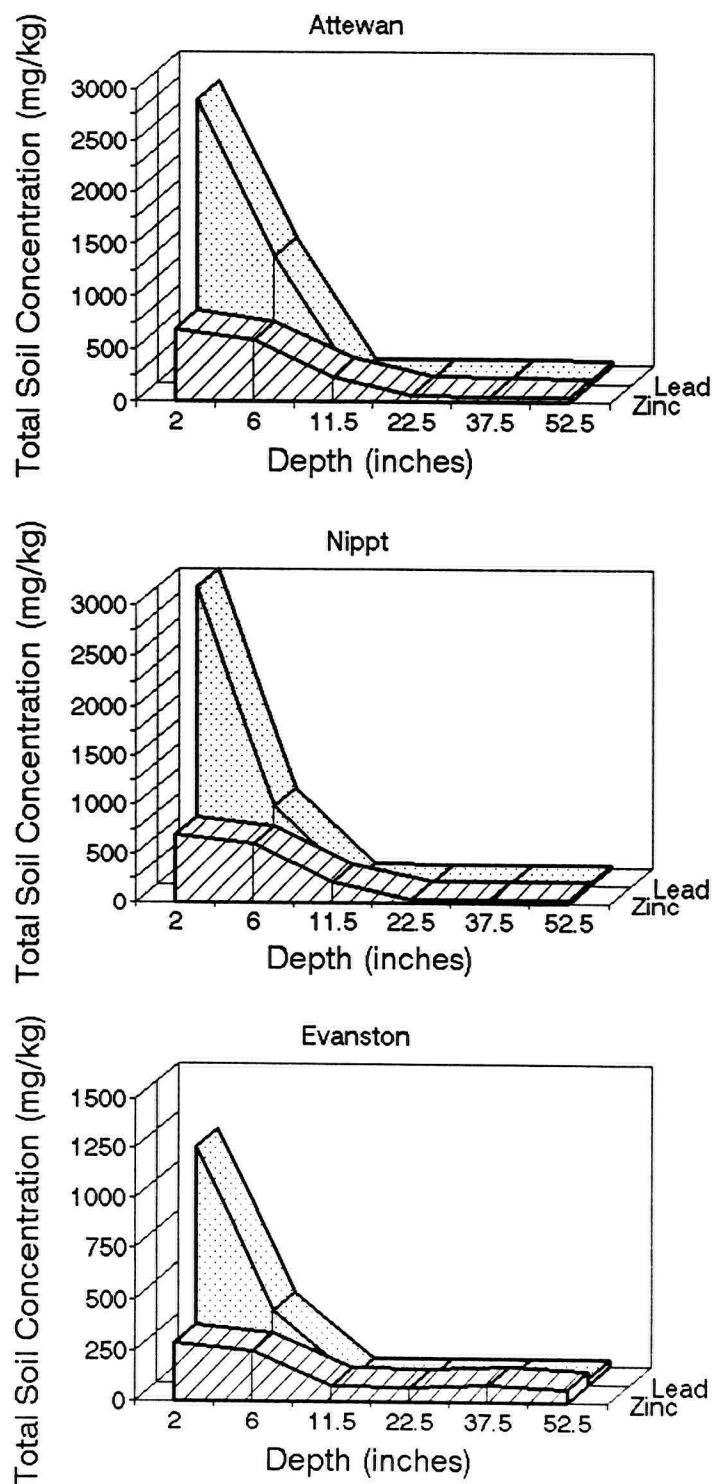
These parameters will directly influence the attenuation of arsenic, cadmium, lead and zinc and will control the migration and vertical distribution of arsenic and metals observed in the East Field soils. The primary attenuation mechanisms that are recognized include precipitation/dissolution and adsorption/desorption (Battelle, 1986).

Total soil concentrations of arsenic, cadmium, lead and zinc in the Attewan, Nippt and Evanston series profiles were evaluated to a depth of 60 inches (Table 1b). Total soil concentrations of lead and zinc are plotted as a function of depth for Attewan, Nippt and Evanston soils in Figure 5. Total soil concentrations of arsenic and cadmium are plotted as a function of depth for Attewan, Nippt and Evanston soils in Figure 6. For all soils, total soil lead concentrations decrease rapidly to background concentrations at a depth of 15 inches. Zinc levels decrease less rapidly and reach background levels at a depth of 15 inches. Compared to lead, zinc appears to be more mobile. Arsenic was similar to lead in that concentrations decreased rapidly to background levels at a depth of one foot in the three soils. Cadmium decreased less rapidly in the Attewan and Nippt soils and reached background at a depth of two feet. In the Evanston soil, concentrations dropped to background at a depth of one foot. Like zinc, cadmium appears to be more mobile in the soil profile than either lead or arsenic.

To determine if total arsenic and metals concentrations were at background at depth in the deep test pits, a comparison of background level information was conducted. In Figure 7, background levels for arsenic, cadmium, lead and zinc are compared for the

**Figure 5**

VERTICAL DISTRIBUTION OF TOTAL SOIL LEAD AND ZINC IN ATTEWAN, NIPPT AND EVANSTON SOILS



**Figure 6**

VERTICAL DISTRIBUTION OF TOTAL SOIL ARSENIC AND CADMIUM IN ATTEWAN, NIPPT AND EVANSTON SOILS

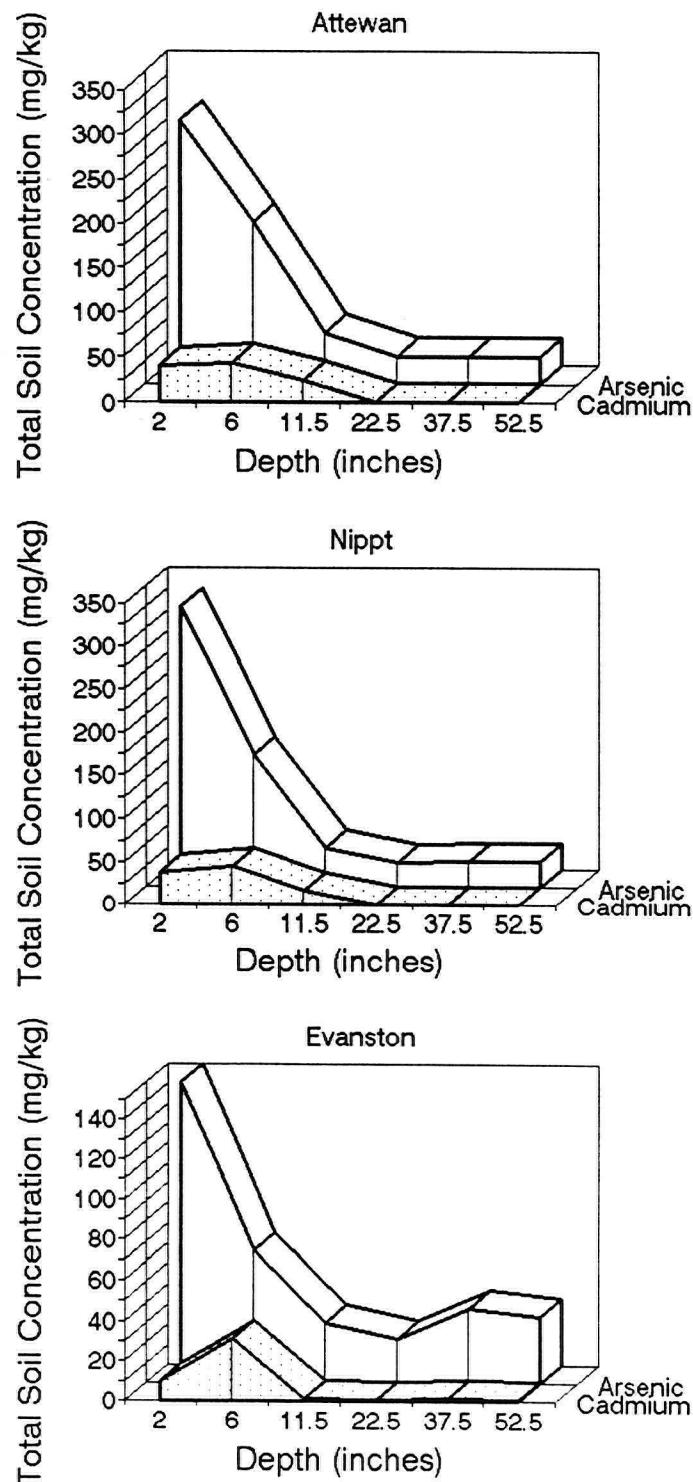
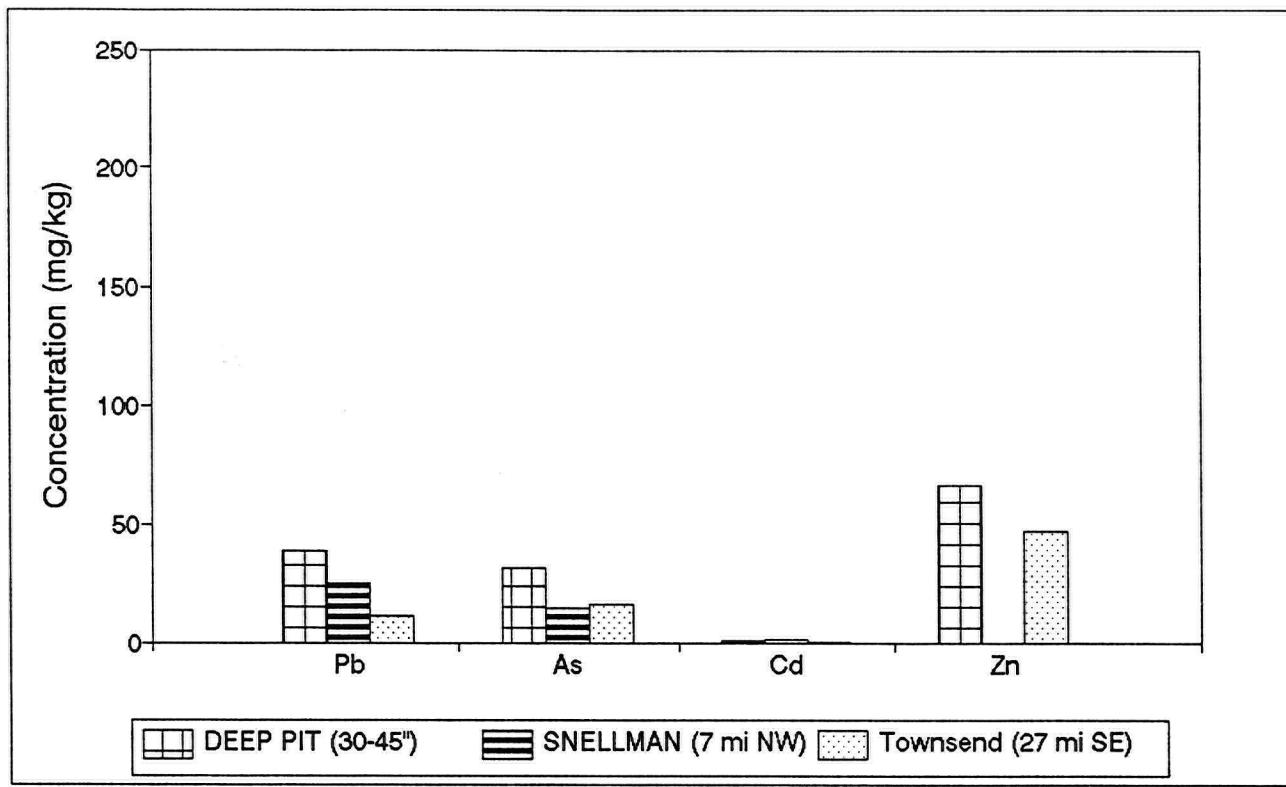


FIGURE 7. COMPARISON OF BACKGROUND LEVELS OF ARSENIC, CADMIUM, LEAD AND ZINC



	Concentration (mg/kg)			
	Pb	As	Cd	Zn
Deep Pit (30-45")	38.6	31.8	0.7	66
Snellman (7 mi. NW)	24.8	14.4	1	
Townsend (27 mi SE)	11.6	16.5	0.24	46.9

East Field deep pits, the Snellman field located seven miles northwest of the Asarco smelter, and for samples collected near Townsend, 27 miles southeast of the smelter in conjunction with the East Helena RI (Hydrometrics, 1990). No zinc data was available for the Snellman field which is a future source of replacement soil for the remediation of East Helena. Total soil arsenic, cadmium and lead analysis results for the Snellman field are in Appendix B. Background levels for total soil arsenic range from 16.5 to 31.8 mg/kg; for total soil cadmium, 0.24 to 0.7 mg/kg; for total soil lead, 11.6 to 38.6 mg/kg and for total soil zinc, 46.9 to 66 mg/kg (Figure 7). Different laboratories, sampling procedures, and extraction procedures; hydrofluoric acid (HF) verses routine analytical service contract laboratory program (RAS CLP), were used at each site so that the range or variability in concentrations can be attributed entirely to these differences. Typically, HF extractions produce higher total arsenic and metal values than RAS CLP extractions. It was concluded that the concentrations of arsenic, cadmium, lead and zinc in the subsurface levels of the Attewan, Nippt and Evanston deep pits were at background levels typical for the area in general.

### **3.2 HYDROLOGIC PERFORMANCE MODELING**

The HELP model was used to determine the potential for moisture as rainfall entering the surface of the East Field soils or a soil cap and percolating to the groundwater system 18 feet below the surface. Total annual and monthly average rainfall and evapotranspiration (ET) data used in the HELP model simulation are in Figure 8. The results of HELP model simulations for a 20-year period are summarized in Table 4 for existing Attewan and Nippt soils and in Table 5 for a 1-foot cap of East Helena

FIGURE 8 ANNUAL AND MONTHLY PRECIPITATION AND ET FOR EAST FIELD SOIL CAP SCENARIOS

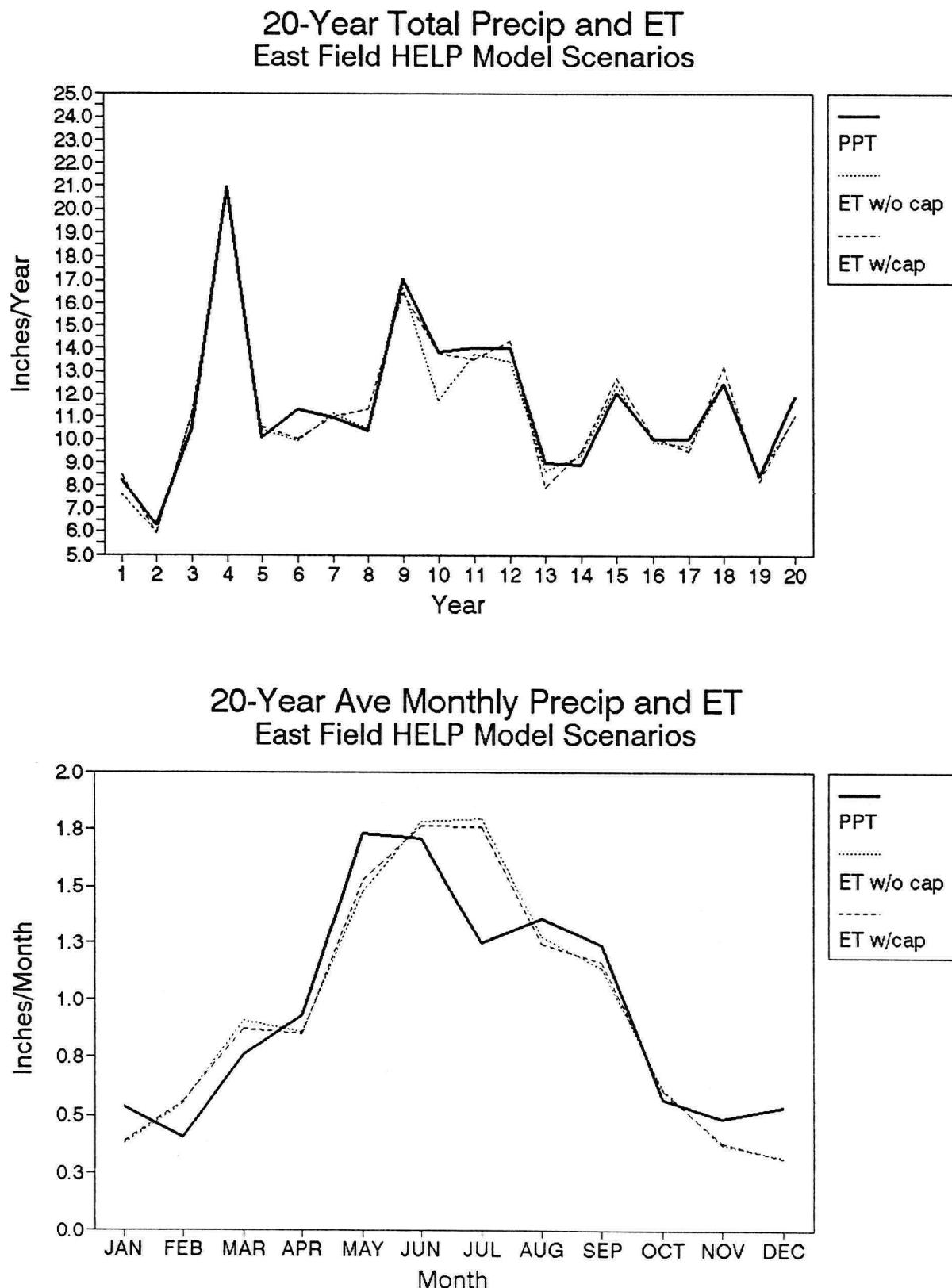


TABLE 4 EAST HELENA FOCUSED FS EAST FIELD SOIL CAP SCENARIOS  
HELP MODEL WATER BUDGET FOR EXISTING CONDITIONS ATTEWAN-NIPPT COMPLEX

YEAR	PRECIPITATION				RUNOFF				EVAPOTRANSPIRATION				PERCOLATION TO GROUNDWATER			
	(in)	(cu ft)	(gal/min)	(%)	(in)	(cu ft)	(gal/min)	(%)	(in)	(cu ft)	(gal/min)	(%)	(in)	(cu ft)	(gal/min)	(%)
1	8.23	3704490	53.05	100	0.000	0	0.00	0.00	7.63	3436368	49.21	92.76	0.000	0	0.00	0.00
2	6.27	2822252	40.41	100	0.000	0	0.00	0.00	5.98	2693812	38.58	95.45	0.000	0	0.00	0.00
3	10.46	4708256	67.42	100	0.000	0	0.00	0.00	11.11	5001570	71.62	106.23	0.000	0	0.00	0.00
4	20.96	9434519	135.10	100	0.002	935	0.01	0.01	20.70	9318431	133.44	98.77	0.000	0	0.00	0.00
5	10.07	4532710	64.91	100	0.000	0	0.00	0.00	10.45	4705237	67.38	103.81	0.000	0	0.00	0.00
6	11.34	5104364	73.09	100	0.000	0	0.00	0.00	9.93	4468266	63.99	87.54	0.000	0	0.00	0.00
7	10.97	4937818	70.71	100	0.000	0	0.00	0.00	11.15	5019938	71.89	101.67	0.000	0	0.00	0.00
8	10.39	4676748	66.97	100	0.035	9965	0.14	0.34	10.46	4709549	67.44	100.70	0.000	0	0.00	0.00
9	17.06	7679048	109.96	100	0.015	6759	0.10	0.09	16.66	7497334	107.36	97.63	0.000	0	0.00	0.00
10	13.83	6225161	89.14	100	0.197	88576	1.27	1.42	11.74	5283999	75.67	84.88	0.000	0	0.00	0.00
11	14.01	6306183	90.30	100	0.012	5202	0.07	0.08	13.75	6189618	88.64	98.15	0.000	0	0.00	0.00
12	14.03	6315186	90.43	100	0.038	16802	0.24	0.27	13.41	6036804	86.45	95.59	0.000	0	0.00	0.00
13	9.00	4051081	58.01	100	0.000	0	0.00	0.00	8.64	3887369	55.67	95.96	0.000	0	0.00	0.00
14	8.95	4028576	57.69	100	0.000	0	0.00	0.00	9.31	4189934	60.00	104.01	0.000	0	0.00	0.00
15	12.10	5446454	77.99	100	0.000	0	0.00	0.00	12.42	5589282	80.04	102.62	0.000	0	0.00	0.00
16	10.04	4519207	64.72	100	0.000	0	0.00	0.00	9.90	4457158	63.83	98.63	0.000	0	0.00	0.00
17	10.03	4514705	64.65	100	0.000	0	0.00	0.00	9.72	4374441	62.64	96.90	0.000	0	0.00	0.00
18	12.51	5631003	80.64	100	0.000	0	0.00	0.00	12.44	5599153	80.18	99.43	0.000	0	0.00	0.00
19	8.43	3794512	54.34	100	0.000	0	0.00	0.00	8.49	3821447	54.72	100.71	0.000	0	0.00	0.00
20	11.92	5365431	76.83	100	0.000	0	0.00	0.00	10.99	4946639	70.84	92.19	0.000	0	0.00	0.00
Average	11.53	5189885	74.32	100	0.015	6412	0.09	0.11	11.24	5061317	72.48	97.68	0.000	0	0.00	0.00

TABLE 5 EAST HELENA FOCUSED FS EAST FIELD SOIL CAP SCENARIOS  
HELP MODEL WATER BUDGET FOR ATTEWAN-NIPPT COMPLEX WITH RESIDENTIAL SOIL CAP

YEAR	PRECIPITATION				RUNOFF				EVAPOTRANSPIRATION				PERCOLATION TO GROUNDWATER			
	(in)	(cu ft)	(gal/min)	(%)	(in)	(cu ft)	(gal/min)	(%)	(in)	(cu ft)	(gal/min)	(%)	(in)	(cu ft)	(gal/min)	(%)
1	8.23	3704490	53.05	100	0	0	0.00	0	8.48	3818233	54.68	103.07	0.000	0	0.00	0.00
2	6.27	2822252	40.41	100	0	0	0.00	0	5.91	2660117	38.09	94.26	0.000	0	0.00	0.00
3	10.46	4708256	67.42	100	0	0	0.00	0	11.16	5023573	71.94	106.70	0.000	0	0.00	0.00
4	20.96	9434519	135.10	100	0	0	0.00	0	20.57	9259818	132.60	98.15	0.000	0	0.00	0.00
5	10.07	4532710	64.91	100	0	0	0.00	0	10.60	4773350	68.35	105.31	0.000	0	0.00	0.00
6	11.34	5104364	73.09	100	0	0	0.00	0	10.04	4517312	64.69	88.50	0.000	0	0.00	0.00
7	10.97	4937818	70.71	100	0	0	0.00	0	11.00	4950658	70.89	100.26	0.000	0	0.00	0.00
8	10.39	4676748	66.97	100	0	0	0.00	0	11.37	5117087	73.28	109.41	0.000	0	0.00	0.00
9	17.06	7679048	109.96	100	0	0	0.00	0	16.42	7389212	105.81	96.23	0.000	0	0.00	0.00
10	13.83	6225161	89.14	100	0	0	0.00	0	13.82	6218738	89.05	99.90	0.000	0	0.00	0.00
11	14.01	6306183	90.30	100	0	0	0.00	0	13.53	6091918	87.24	96.60	0.000	0	0.00	0.00
12	14.03	6315186	90.43	100	0	0	0.00	0	14.33	6451357	92.38	102.15	0.000	0	0.00	0.00
13	9.00	4051081	58.01	100	0	0	0.00	0	7.94	3572836	51.16	88.20	0.000	0	0.00	0.00
14	8.95	4028576	57.69	100	0	0	0.00	0	9.52	4286171	61.38	106.39	0.000	0	0.00	0.00
15	12.10	5446454	77.99	100	0	0	0.00	0	12.74	5734360	82.12	105.29	0.000	0	0.00	0.00
16	10.04	4519207	64.72	100	0	0	0.00	0	10.14	4562193	65.33	100.95	0.000	0	0.00	0.00
17	10.03	4514705	64.65	100	0	0	0.00	0	9.50	4274100	61.21	94.67	0.000	0	0.00	0.00
18	12.51	5631003	80.64	100	0	0	0.00	0	13.23	5954288	85.27	105.75	0.000	0	0.00	0.00
19	8.43	3794512	54.34	100	0	0	0.00	0	8.19	3686260	52.79	97.15	0.000	0	0.00	0.00
20	11.92	5365431	76.83	100	0	0	0.00	0	11.06	4978011	71.29	92.78	0.000	0	0.00	0.00
Average	11.53	5189885	74.32	100	0.000	0	0.00	0.00	11.48	5165980	73.98	99.59	0.000	0	0.00	0.00

residential soils placed over Attewan and Nippt soils. The ET values generated by the HELP model appeared to be lower than would be normal for the area. In addition, level slope conditions were assumed for the simulation area. Therefore, the estimations of runoff and percolation were considered to be conservative. Detailed HELP model input and output for individual existing soil or soil cap simulations are in Appendix C.

According to HELP model simulation results, there is no percolation to the ground water system occurring under existing conditions (Table 5) and there would be no potential for percolation with the addition of a 1-foot cap of East Helena residential soil. Accordingly, there would be no potential for arsenic and metals to percolate to the groundwater system under either of these scenarios.

There would be potential changes in the distribution of moisture in the soil profile with the addition of the soil cap. The HELP model calculated the soil moisture for each layer for the last year of the simulation. Estimates of volumetric soil moisture for the initial and final year of the simulation for the Attewan series with and without a residential soil cap are in Figure 9. Estimates of volumetric soil moisture for the initial and final year of the simulation for the Nippt series with and without a residential soil cap is in Figure 10. As a point of reference, Figures 9 and 10 also plot the field capacity and wilting point moisture content for each layer. For the Attewan series (Figure 9), there was no increase in soil moisture content in the alluvial outwash from initial conditions for existing or cap scenarios. The addition of a soil cap reduces the moisture content in the 5-foot soil profile layers underlying the cap compared to existing or no soil

FIGURE 9 SOIL MOISTURE CHANGES IN ATTEWAN AND ALLUVIAL OUTWASH FOR 20 YEAR PERIOD

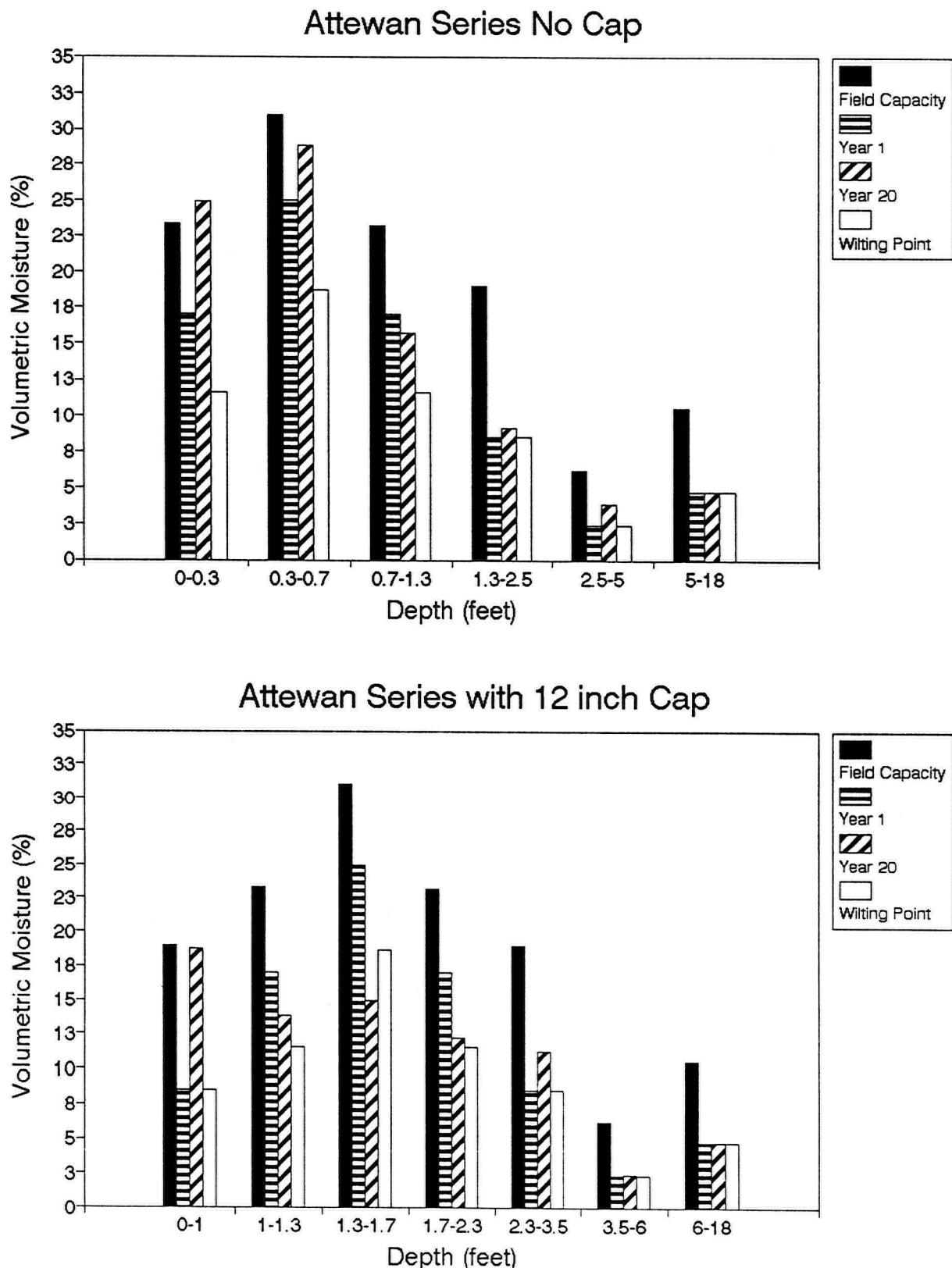
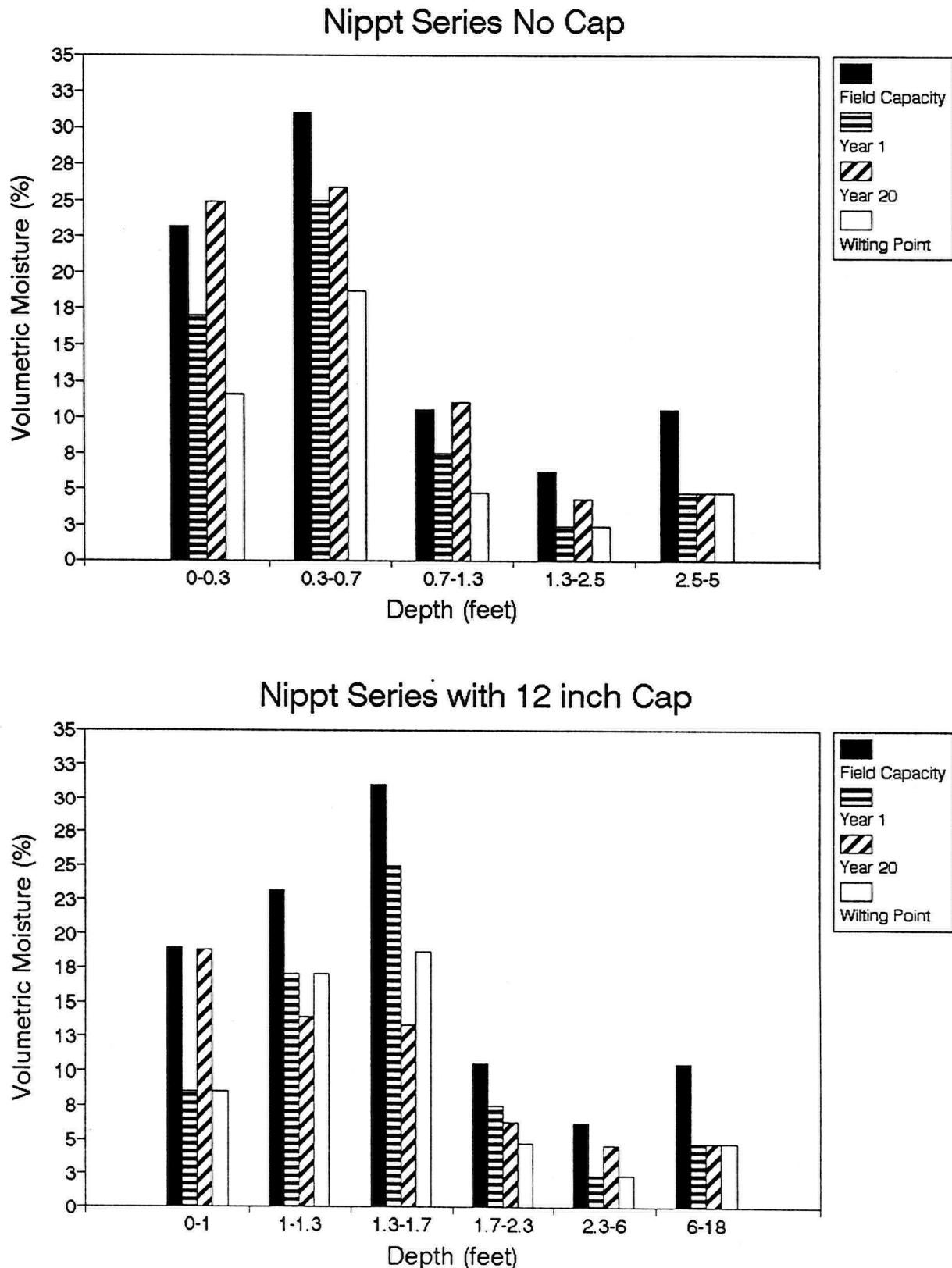


FIGURE 10 SOIL MOISTURE CHANGES IN NIPPT AND ALLUVIAL OUTWASH FOR 20 YEAR PERIOD



cap conditions. The difference in stored moisture is essentially taken up by the 1-foot cap of residential soil. The same general trends in soil moisture changes were observed for the Nippt series (Figure 10).

### **3.3 ARSENIC AND METALS MOBILITY**

In Section 3.1, the results of total arsenic and metals analysis for deep test pits was discussed. There was strong evidence to support that arsenic, cadmium, lead and zinc have not migrated in the native soil profiles evaluated below a depth of one or two feet (Figures 5 and 6). However, the need to statistically confirm the trends observed in the deep pits was recognized and total soil arsenic and metals data collected from the grid coordinates in the East Field (Figure 1), when combined with deep pit data, (Table 1b) provided this opportunity. Plots of empirical data and regression curves for transformed (percent of total surface concentration) arsenic, lead and zinc data are in Figures 11, 12 and 13, respectively. The regression formulas and other supporting information used to calculate the curves are in Table 6. Cadmium data were too variable to provide meaningful regression analysis. Also included in Figures 11, 12 and 13 are curves which predict the concentration of arsenic, lead or zinc at depths given a range of possible surface concentrations. These curves were calculated by taking the predicted concentration at a given depth expressed as a percent of the surface (0-4 inches) concentration according to the regression formulas and multiplying by an assumed surface concentration in mg/kg. The data that were generated by this method are in Appendix D.

FIGURE 11. 1992 EAST FIELD SOIL SAMPLES  
Evaluation Of As Mobility (Deep Pits & Soil Grid)

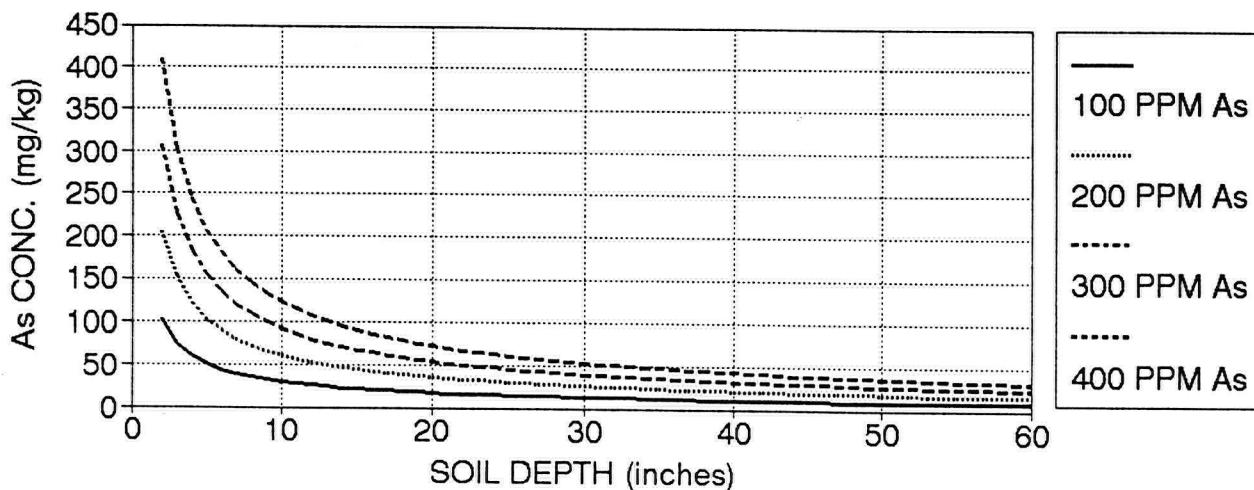
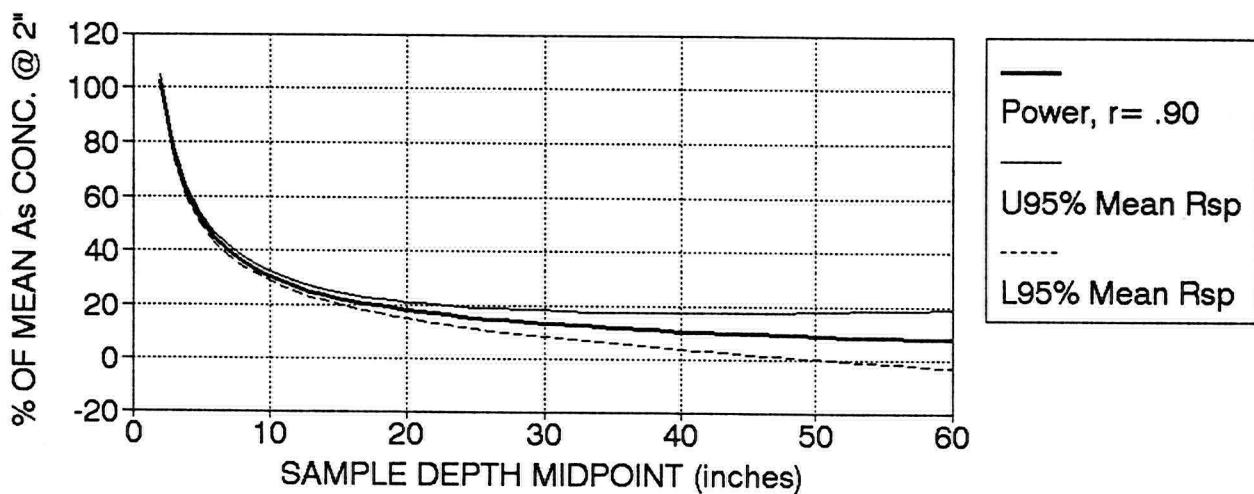
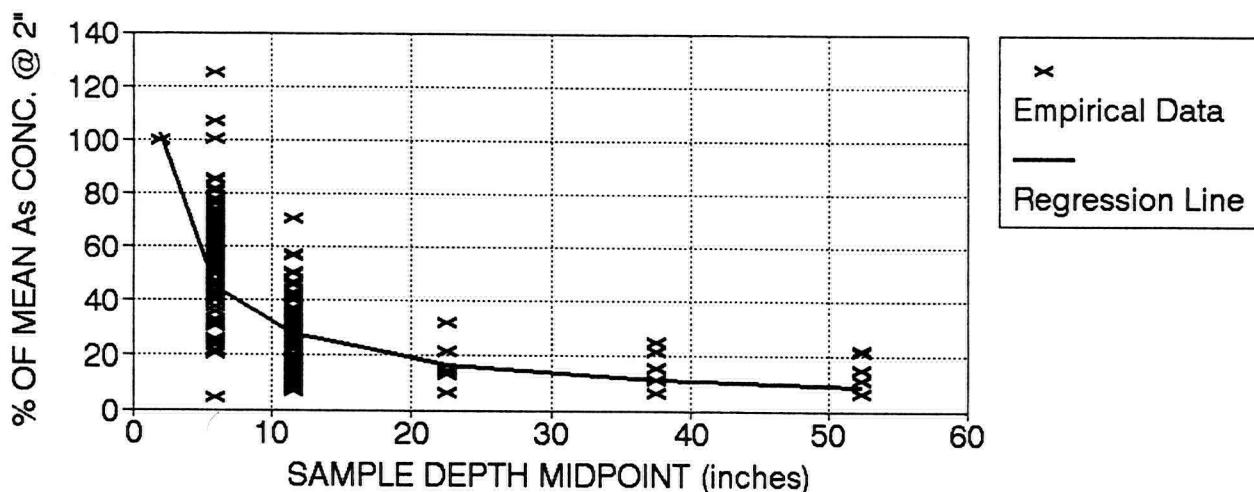


FIGURE 12. 1992 EAST FIELD SOIL SAMPLES  
Evaluation Of Pb Mobility (Deep Pits & Soil Grid)

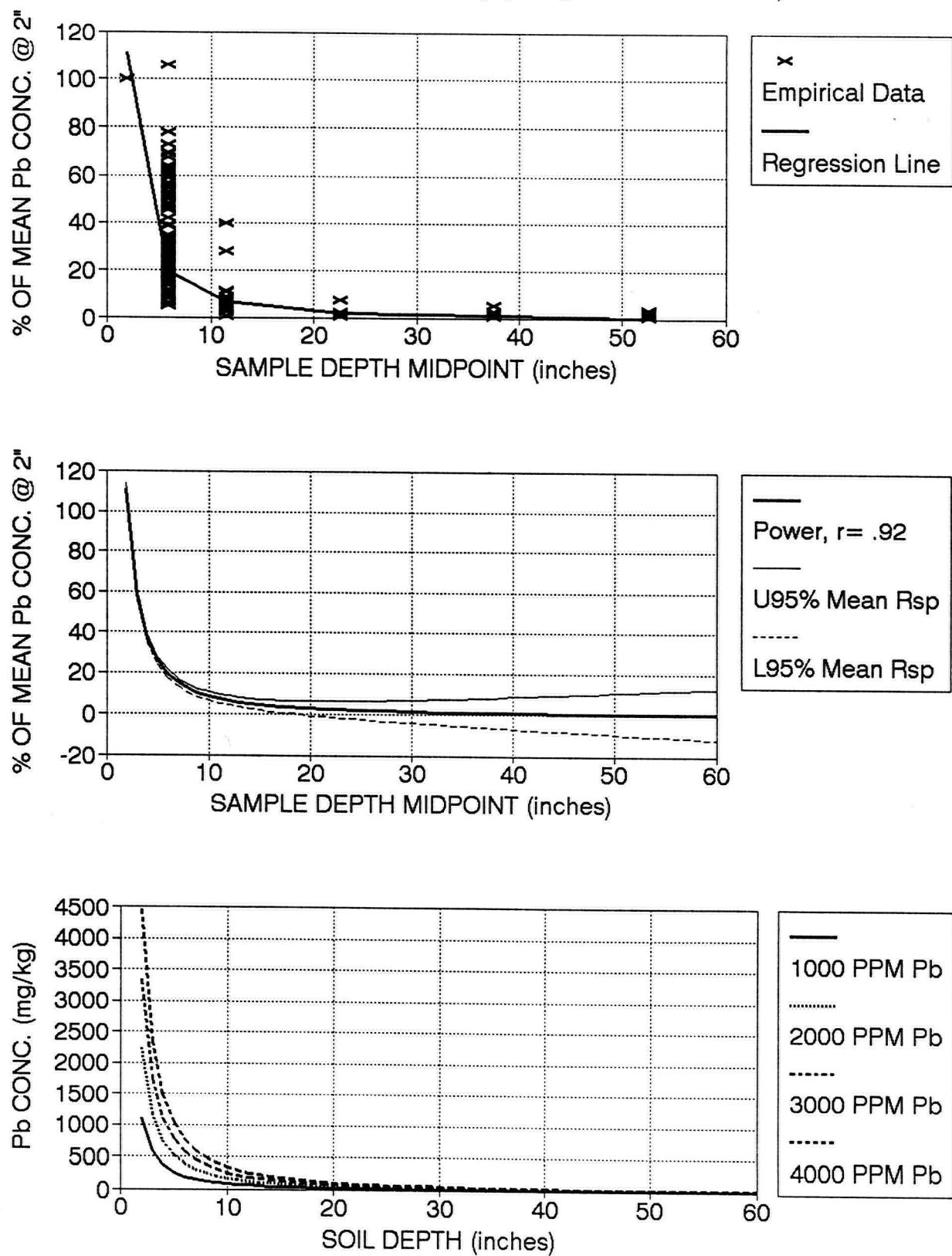
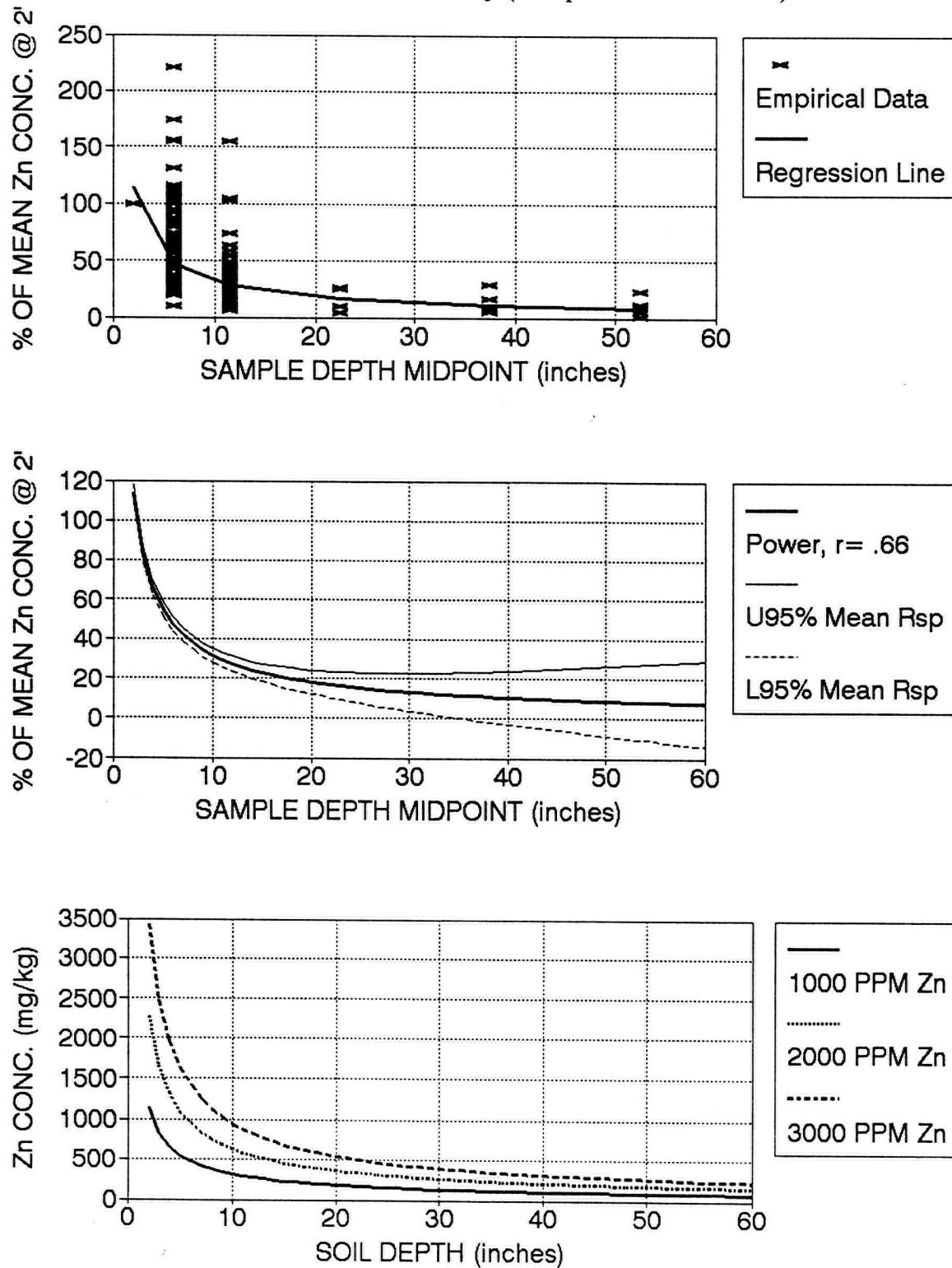


FIGURE 13. 1992 EAST FIELD SOIL SAMPLES  
Evaluation Of Zn Mobility (Deep Pits & Soil Grid)



**TABLE 6. REGRESSION EQUATIONS FOR THE VERTICAL  
DISTRIBUTION OF TOTAL ARSENIC, LEAD AND  
ZINC IN EAST FIELD SOILS**

Element	N	n-2	r	Regression Equation
Arsenic	267	265	0.897	$- 0.747458$ $Y = 2.2354886X$
Lead	267	265	0.915	$- 1.591577$ $Y = 335.07304X$
Zinc	267	265	0.661	$- 0.799352$ $Y = 2.2972241X$

Y is percent of the surface concentration

X is soil depth

The results of regression analysis indicate that there is a strong negative correlation between the total soil concentration of arsenic and soil depth (Table 6), and that concentrations decrease in a highly predictable manner to background soil levels at a depth of 2 feet. These reductions in the concentrations of arsenic and metals were attributed to natural layers of clay and carbonate and associated attenuating properties found in the soil horizons as previously discussed in Section 3.1.

#### 4.0 REFERENCES

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- USDA SCS, Date Unknown. Soil Survey of Helena Valley.

**APPENDIX A.**

**TRANSFORMED TOTAL SOIL ARSENIC, CADMIUM, LEAD  
AND ZINC DATA USED FOR REGRESSION ANALYSIS OF MOBILITY**

## 1992 EAST FIELD SOIL SAMPLES

sample number	depth	Pb	As	Cd	Zn	Transformation To % Of Surface Concentration			
						Pb	As	Cd	Zn
1250x1250y	4	3216	371	74	1261	100.0	100.0	100.0	100.0
1250x1250y	8	743	203	13	264	23.1	54.7	17.6	20.9
1250x1250y	15	84	152	2	111	2.6	41.0	2.7	8.8
1250x2000y	4	4874	545	101	3250	100.0	100.0	100.0	100.0
1250x2000y	8	1178	207	35	912	24.2	38.0	34.7	28.1
1250x2000y	15	539	228	11	229	11.1	41.8	10.9	7.0
1250x2250y	4	2854	239	38	1292	100.0	100.0	100.0	100.0
1250x2250y	8	1673	193	43	1189	58.6	80.8	113.2	92.0
1250x2250y	15	796	121	19	387	27.9	50.6	50.0	30.0
1250x2500y	4	2416	259	31	945	100.0	100.0	100.0	100.0
1250x2500y	8	1467	168	44	1065	60.7	64.9	141.9	112.7
1250x2500y	15	98	77	8	188	4.1	29.7	25.8	19.9
1250x2750y	4	1491	153	17	656	100.0	100.0	100.0	100.0
1250x2750y	8	292	97	22	414	19.6	63.4	129.4	63.1
1250x2750y	15	58	56	2	171	3.9	36.6	11.8	26.1
1250x3000y	4	1817	164	34	771	100.0	100.0	100.0	100.0
1250x3000y	8	525	120	21	444	28.9	73.2	61.8	57.6
1250x3000y	15	112	40	2	315	6.2	24.4	5.9	40.9
1500x1250y	4	3337	389	46	982	100.0	100.0	100.0	100.0
1500x1250y	8	1526	220	55	692	45.7	56.6	119.6	70.5
1500x1250y	15	85	92	2	118	2.5	23.7	4.3	12.0
1500x1500y	4	3119	337	39	928	100.0	100.0	100.0	100.0
1500x1500y	8	818	153	41	520	26.2	45.4	105.1	56.0
1500x1500y	15	77	118	2	111	2.5	35.0	5.1	12.0
1500x1750y	4	3363	348	82	1487	100.0	100.0	100.0	100.0
1500x1750y	8	818	175	15	296	24.3	50.3	18.3	19.9
1500x1750y	15	83	58	2	113	2.5	16.7	2.4	7.6
1500x2000y	4	2568	195	63	1199	100.0	100.0	100.0	100.0
1500x2000y	8	1787	152	38	814	69.6	77.9	60.3	67.9
1500x2000y	15	75	83	2	116	2.9	42.6	3.2	9.7
1500x2250y	4	2789	219	64	1473	100.0	100.0	100.0	100.0
1500x2250y	8	1434	155	32	682	51.4	70.8	50.0	46.3
1500x2250y	15	123	82	7	147	4.4	37.4	10.9	10.0
1500x2500y	4	2372	208	37	1086	100.0	100.0	100.0	100.0
1500x2500y	8	716	110	35	626	30.2	52.9	94.6	57.6
1500x2500y	15	90	75	2	119	3.8	36.1	5.4	11.0
1500x2750y	4	1957	196	34	928	100.0	100.0	100.0	100.0
1500x2750y	8	513	85	13	277	26.2	43.4	38.2	29.8
1500x2750y	15	79	78	2	126	4.0	39.8	5.9	13.6
1750x1250y	4	3015	348	42	436	100.0	100.0	100.0	100.0
1750x1250y	8	1429	215	53	679	47.4	61.8	126.2	155.7
1750x1250y	15	79	78	2	114	2.6	22.4	4.8	26.1
1750x1500y	4	2932	356	24	737	100.0	100.0	100.0	100.0
1750x1500y	8	1722	264	84	967	58.7	74.2	350.0	131.2

## 1992 EAST FIELD SOIL SAMPLES

sample number	depth	Pb	As	Cd	Zn	Transformation To % Of Surface Concentration			
						Pb	As	Cd	Zn
1750x1500y	15	86	83	42	221	2.9	23.3	175.0	30.0
1750x2250y	4	2105	259	22	751	100.0	100.0	100.0	100.0
1750x2250y	8	169	66	46	515	8.0	25.5	209.1	68.6
1750x2250y	15	65	57	2	108	3.1	22.0	9.1	14.4
1750x2500y	4	1913	255	17	690	100.0	100.0	100.0	100.0
1750x2500y	8	409	104	29	511	21.4	40.8	170.6	74.1
1750x2500y	15	65	48	5	116	3.4	18.8	29.4	16.8
1750x3000y	4	1475	165	39	1207	100.0	100.0	100.0	100.0
1750x3000y	8	92	54	4	121	6.2	32.7	10.3	10.0
1750x3000y	15	58	41	2	85	3.9	24.8	5.1	7.0
2000x1250y	4	2395	317	15	465	100.0	100.0	100.0	100.0
2000x1250y	8	692	131	21	407	28.9	41.3	140.0	87.5
2000x1250y	15	69	35	19	195	2.9	11.0	126.7	41.9
2000x1500y	4	2348	321	31	634	100.0	100.0	100.0	100.0
2000x1500y	8	720	133	44	539	30.7	41.4	141.9	85.0
2000x1500y	15	90	44	9	108	3.8	13.7	29.0	17.0
2000x2250y	4	2722	331	34	990	100.0	100.0	100.0	100.0
2000x2250y	8	1142	154	45	681	42.0	46.5	132.4	68.8
2000x2250y	15	89	44	3	110	3.3	13.3	8.8	11.1
2000x2500y	4	2728	261	58	1366	100.0	100.0	100.0	100.0
2000x2500y	8	795	149	19	351	29.1	57.1	32.8	25.7
2000x2500y	15	66	76	2	113	2.4	29.1	3.4	8.3
2000x2750y	4	1566	199	18	543	100.0	100.0	100.0	100.0
2000x2750y	8	171	65	26	357	10.9	32.7	144.4	65.7
2000x2750y	15	69	36	2	83	4.4	18.1	11.1	15.3
2250x1250y	4	2009	246	11	446	100.0	100.0	100.0	100.0
2250x1250y	8	1282	201	11	389	63.8	81.7	100.0	87.2
2250x1250y	15	102	44	22	218	5.1	17.9	200.0	48.9
2250x1500y	4	1822	292	14	402	100.0	100.0	100.0	100.0
2250x1500y	8	820	171	27	464	45.0	58.6	192.9	115.4
2250x1500y	15	103	57	33	413	5.7	19.5	235.7	102.7
2250x1750y	4	2323	271	46	847	100.0	100.0	100.0	100.0
2250x1750y	8	724	177	40	437	31.2	65.3	87.0	51.6
2250x1750y	15	83	71	5	115	3.6	26.2	10.9	13.6
2250x2000y	4	2321	246	32	715	100.0	100.0	100.0	100.0
2250x2000y	8	1160	173	58	767	50.0	70.3	181.3	107.3
2250x2000y	15	162	106	2	134	7.0	43.1	6.3	18.7
2250x2250y	4	2599	238	57	1235	100.0	100.0	100.0	100.0
2250x2250y	8	908	164	20	398	34.9	68.9	35.1	32.2
2250x2250y	15	71	70	2	104	2.7	29.4	3.5	8.4
2250x2500y	4	1758	202	21	572	100.0	100.0	100.0	100.0
2250x2500y	8	533	114	16	356	30.3	56.4	76.2	62.2
2250x2500y	15	78	25	2	152	4.4	12.4	9.5	26.6
2500x1250y	4	2279	264	34	685	100.0	100.0	100.0	100.0

## 1992 EAST FIELD SOIL SAMPLES

sample number	depth	Pb	As	Cd	Zn	Transformation To % Of Surface Concentration			
						Pb	As	Cd	Zn
2500x1250y	8	1178	204	51	506	51.7	77.3	150.0	73.9
2500x1250y	15	87	38	7	150	3.8	14.4	20.6	21.9
2500x1500y	4	2678	248	59	976	100.0	100.0	100.0	100.0
2500x1500y	8	520	156	7	184	19.4	62.9	11.9	18.9
2500x1500y	15	106	79	2	123	4.0	31.9	3.4	12.6
2500x1750y	4	2661	280	32	451	100.0	100.0	100.0	100.0
2500x1750y	8	1338	167	74	783	50.3	59.6	231.3	173.6
2500x1750y	15	231	131	2	140	8.7	46.8	6.3	31.0
2500x2000y	4	1641	209	9	352	100.0	100.0	100.0	100.0
2500x2000y	8	1192	159	16	380	72.6	76.1	177.8	108.0
2500x2000y	15	74	30	14	225	4.5	14.4	155.6	63.9
2500x2250y	4	1715	224	17	449	100.0	100.0	100.0	100.0
2500x2250y	8	795	151	39	464	46.4	67.4	229.4	103.3
2500x2250y	15	64	51	4	221	3.7	22.8	23.5	49.2
2500x2500y	4	1597	208	11	462	100.0	100.0	100.0	100.0
2500x2500y	8	1019	153	10	381	63.8	73.6	90.9	82.5
2500x2500y	15	76	57	16	293	4.8	27.4	145.5	63.4
2500x2750y	4	1746	211	31	613	100.0	100.0	100.0	100.0
2500x2750y	8	588	115	19	393	33.7	54.5	61.3	64.1
2500x2750y	15	140	53	12	181	8.0	25.1	38.7	29.5
2750x1250y	4	2673	252	63	986	100.0	100.0	100.0	100.0
2750x1250y	8	628	132	15	238	23.5	52.4	23.8	24.1
2750x1250y	15	119	78	2	113	4.5	31.0	3.2	11.5
2750x1500y	4	2138	250	19	541	100.0	100.0	100.0	100.0
2750x1500y	8	1127	180	27	451	52.7	72.0	142.1	83.4
2750x1500y	15	79	38	15	175	3.7	15.2	78.9	32.3
2750x1750y	4	2551	296	31	722	100.0	100.0	100.0	100.0
2750x1750y	8	1163	174	41	526	45.6	58.8	132.3	72.9
2750x1750y	15	109	59	17	174	4.3	19.9	54.8	24.1
2750x2000y	4	2300	239	27	704	100.0	100.0	100.0	100.0
2750x2000y	8	1204	181	19	401	52.3	75.7	70.4	57.0
2750x2000y	15	114	79	34	386	5.0	33.1	125.9	54.8
2750x2250y	4	1470	190	11	422	100.0	100.0	100.0	100.0
2750x2250y	8	173	9	41	445	11.8	4.7	372.7	105.5
2750x2250y	15	63	17	2	146	4.3	8.9	18.2	34.6
2750x2500y	4	1585	179	14	471	100.0	100.0	100.0	100.0
2750x2500y	8	866	42	20	409	54.6	23.5	142.9	86.8
2750x2500y	15	63	17	5	209	4.0	9.5	35.7	44.4
2750x2750y	4	1355	149	37	536	100.0	100.0	100.0	100.0
2750x2750y	8	425	74	8	194	31.4	49.7	21.6	36.2
2750x2750y	15	85	52	4	99	6.3	34.9	10.8	18.5
3000x1250y	4	1528	182	42	513	100.0	100.0	100.0	100.0
3000x1250y	8	237	105	4	140	15.5	57.7	9.5	27.3
3000x1250y	15	71	67	2	107	4.6	36.8	4.8	20.9

## 1992 EAST FIELD SOIL SAMPLES

sample number	depth	Pb	As	Cd	Zn	Transformation To % Of Surface Concentration			
						Pb	As	Cd	Zn
3000x1500y	4	1637	211	24	509	100.0	100.0	100.0	100.0
3000x1500y	8	767	124	32	362	46.9	58.8	133.3	71.1
3000x1500y	15	72	57	2	103	4.4	27.0	8.3	20.2
3000x1750y	4	1500	166	35	224	100.0	100.0	100.0	100.0
3000x1750y	8	1039	112	19	494	69.3	67.5	54.3	220.5
3000x1750y	15	598	94	15	348	39.9	56.6	42.9	155.4
3000x2000y	4	1781	207	17	500	100.0	100.0	100.0	100.0
3000x2000y	8	571	127	29	326	32.1	61.4	170.6	65.2
3000x2000y	15	66	63	2	521	3.7	30.4	11.8	104.2
3000x2250y	4	1639	194	18	412	100.0	100.0	100.0	100.0
3000x2250y	8	1107	133	36	456	67.5	68.6	200.0	110.7
3000x2250y	15	92	61	2	142	5.6	31.4	11.1	34.5
3000x2500y	4	1826	202	17	485	100.0	100.0	100.0	100.0
3000x2500y	8	1130	120	33	388	61.9	59.4	194.1	80.0
3000x2500y	15	97	75	2	137	5.3	37.1	11.8	28.2
3250x1250y	4	1567	192	36	536	100.0	100.0	100.0	100.0
3250x1250y	8	266	69	27	233	17.0	35.9	75.0	43.5
3250x1250y	15	56	59	2	77	3.6	30.7	5.6	14.4
3250x1500y	4	2119	243	31	613	100.0	100.0	100.0	100.0
3250x1500y	8	206	75	19	209	9.7	30.9	61.3	34.1
3250x1500y	15	58	40	2	106	2.7	16.5	6.5	17.3
3250x1750y	4	2459	286	27	617	100.0	100.0	100.0	100.0
3250x1750y	8	636	157	23	380	25.9	54.9	85.2	61.6
3250x1750y	15	98	30	19	166	4.0	10.5	70.4	26.9
3250x2000y	4	2046	292	29	511	100.0	100.0	100.0	100.0
3250x2000y	8	414	73	50	518	20.2	25.0	172.4	101.4
3250x2000y	15	82	21	11	184	4.0	7.2	37.9	36.0
3250x2250y	4	868	143	30	434	100.0	100.0	100.0	100.0
3250x2250y	8	76	31	48	474	8.8	21.7	160.0	109.2
3250x2250y	15	61	26	2	125	7.0	18.2	6.7	28.8
3250x2500y	4	1099	131	11	240	100.0	100.0	100.0	100.0
3250x2500y	8	858	164	19	371	78.1	125.2	172.7	154.6
3250x2500y	15	92	29	12	178	8.4	22.1	109.1	74.2
3500x1250y	4	2021	188	40	658	100.0	100.0	100.0	100.0
3500x1250y	8	787	133	21	283	38.9	70.7	52.5	43.0
3500x1250y	15	58	108	6	103	2.9	57.4	15.0	15.7
3500x1500y	4	1493	194	14	417	100.0	100.0	100.0	100.0
3500x1500y	8	293	97	34	256	19.6	50.0	242.9	61.4
3500x1500y	15	82	43	2	107	5.5	22.2	14.3	25.7
3500x1750y	4	1308	221	4	294	100.0	100.0	100.0	100.0
3500x1750y	8	210	53	15	202	16.1	24.0	375.0	68.7
3500x1750y	15	46	55	7	82	3.5	24.9	175.0	27.9
3500x2000y	4	2468	222	49	679	100.0	100.0	100.0	100.0
3500x2000y	8	447	123	34	436	18.1	55.4	69.4	64.2

## 1992 EAST FIELD SOIL SAMPLES

sample number	depth	Pb	As	Cd	Zn	Transformation To % Of Surface Concentration			
						Pb	As	Cd	Zn
3500x2000y	15	86	42	2	121	3.5	18.9	4.1	17.8
3500x2250y	4	2347	258	18	477	100.0	100.0	100.0	100.0
3500x2250y	8	432	104	27	319	18.4	40.3	150.0	66.9
3500x2250y	15	79	21	6	180	3.4	8.1	33.3	37.7
3500x2500y	4	1291	142	36	536	100.0	100.0	100.0	100.0
3500x2500y	8	336	86	30	369	26.0	60.6	83.3	68.8
3500x2500y	15	145	41	2	128	11.2	28.9	5.6	23.9
3750x1250y	4	1563	199	20	472	100.0	100.0	100.0	100.0
3750x1250y	8	603	143	31	287	38.6	71.9	155.0	60.8
3750x1250y	15	80	45	2	125	5.1	22.6	10.0	26.5
3750x1500y	4	1641	143	38	552	100.0	100.0	100.0	100.0
3750x1500y	8	1008	144	18	347	61.4	100.7	47.4	62.9
3750x1500y	15	64	101	2	99	3.9	70.6	5.3	17.9
3750x1750y	4	1289	162	9	306	100.0	100.0	100.0	100.0
3750x1750y	8	777	123	21	402	60.3	75.9	233.3	131.4
3750x1750y	15	76	54	22	165	5.9	33.3	244.4	53.9
3750x2000y	4	1293	166	10	294	100.0	100.0	100.0	100.0
3750x2000y	8	175	43	22	205	13.5	25.9	220.0	69.7
3750x2000y	15	63	46	2	102	4.9	27.7	20.0	34.7
3750x2250y	4	2227	241	22	494	100.0	100.0	100.0	100.0
3750x2250y	8	428	124	8	177	19.2	51.5	36.4	35.8
3750x2250y	15	72	23	23	312	3.2	9.5	104.5	63.2
3750x2500y	4	1882	206	43	622	100.0	100.0	100.0	100.0
3750x2500y	8	317	127	17	289	16.8	61.7	39.5	46.5
3750x2500y	15	63	32	2	116	3.3	15.5	4.7	18.6
4250x1250y	4	1573	206	8	368	100.0	100.0	100.0	100.0
4250x1250y	8	882	119	32	351	56.1	57.8	400.0	95.4
4250x1250y	15	64	64	2	96	4.1	31.1	25.0	26.1
4250x1750y	4	1733	218	8	378	100.0	100.0	100.0	100.0
4250x1750y	8	344	45	22	73	19.8	20.6	275.0	19.3
4250x1750y	15	64	59	5	241	3.7	27.1	62.5	63.8
4250x2250y	4	1558	166	29	478	100.0	100.0	100.0	100.0
4250x2250y	8	973	142	17	345	62.5	85.5	58.6	72.2
4250x2250y	15	65	40	2	126	4.2	24.1	6.9	26.4
4750x1250y	4	1320	179	10	315	100.0	100.0	100.0	100.0
4750x1250y	8	812	108	21	291	61.5	60.3	210.0	92.4
4750x1250y	15	50	27	4	119	3.8	15.1	40.0	37.8
4750x1750y	4	1225	146	12	346	100.0	100.0	100.0	100.0
4750x1750y	8	890	124	16	282	72.7	84.9	133.3	81.5
4750x1750y	15	55	19	2	120	4.5	13.0	16.7	34.7
4750x2250y	4	1160	177	24	409	100.0	100.0	100.0	100.0
4750x2250y	8	261	58	13	190	22.5	32.8	54.2	46.5
4750x2250y	15	56	28	8	127	4.8	15.8	33.3	31.1
5250x1250y	4	863	129	17	263	100.0	100.0	100.0	100.0

## 1992 EAST FIELD SOIL SAMPLES

sample number	depth	Pb	As	Cd	Zn	Transformation To % Of Surface Concentration			
						Pb	As	Cd	Zn
5250x1250y	8	238	64	20	190	27.6	49.6	117.6	72.2
5250x1250y	15	50	37	3	112	5.8	28.7	17.6	42.6
5250x1750y	4	1143	97	22	144	100.0	100.0	100.0	100.0
5250x1750y	8	179	41	8	135	15.7	42.3	36.4	93.8
5250x1750y	15	57	9	2	84	5.0	9.3	9.1	58.3
5250x2250y	4	981	134	13	311	100.0	100.0	100.0	100.0
5250x2250y	8	213	42	11	173	21.7	31.3	84.6	55.6
5250x2250y	15	56	27	2	106	5.7	20.1	15.4	34.1
5750x1250y	4	1352	136	19	320	100.0	100.0	100.0	100.0
5750x1250y	8	202	79	8	158	14.9	58.1	42.1	49.4
5750x1250y	15	59	30	2	111	4.4	22.1	10.5	34.7
5750x1750y	4	1077	108	18	322	100.0	100.0	100.0	100.0
5750x1750y	8	608	84	11	221	56.5	77.8	61.1	68.6
5750x1750y	15	56	33	4	96	5.2	30.6	22.2	29.8
5750x2250y	4	1146	107	34	401	100.0	100.0	100.0	100.0
5750x2250y	8	251	71	9	150	21.9	66.4	26.5	37.4
5750x2250y	15	50	49	2	64	4.4	45.8	5.9	16.0

## 1992 EAST FIELD DEEP PIT SOIL SAMPLES

Sample Number	Depth	HF (mg/kg)			Transformation To % Of Surface Concentration				
		Pb	As	Cd	Zn	Pb	As	Cd	Zn
Nipt-1	4	1460	200	21	380	100.0	100.0	100.0	100.0
Nipt-1	8	74	94	25	390	5.1	47.0	119.0	102.6
Nipt-1	15	44	30	2	94	3.0	15.0	9.5	24.7
Nipt-1	30	24	27	1	38	1.6	13.5	4.8	10.0
Nipt-1	45	21	32	0.5	31	1.4	16.0	2.4	8.2
Nipt-1	60	30	30	1	33	2.1	15.0	4.8	8.7
Nipt-2	4	4600	450	56	1005	100.0	100.0	100.0	100.0
Nipt-2	8	1540	210	66	800	33.5	46.7	117.9	79.6
Nipt-2	15	41	60	33	320	0.9	13.3	58.9	31.8
Nipt-2	30	33	30	0.5	43	0.7	6.7	0.9	4.3
Nipt-2	45	40	30	0.5	48	0.9	6.7	0.9	4.8
Nipt-2	60	34	30	0.5	50	0.7	6.7	0.9	5.0
Attewan1	4	820	140	25	360	100.0	100.0	100.0	100.0
Attewan1	8	870	150	23	360	106.1	107.1	92.0	100.0
Attewan1	15	58	51	17	170	7.1	36.4	68.0	47.2
Attewan1	30	61	30	1	90	7.4	21.4	4.0	25.0
Attewan1	45	43	30	0.5	60	5.2	21.4	2.0	16.7
Attewan1	60	31	30	0.5	41	3.8	21.4	2.0	11.4
Attewan2	4	3850	260	150	2220	100.0	100.0	100.0	100.0
Attewan2	8	1860	160	49	930	48.3	61.5	32.7	41.9
Attewan2	15	155	130	3	140	4.0	50.0	2.0	6.3
Attewan2	30	43	84	1	101	1.1	32.3	0.7	4.5
Attewan2	45	54	30	1	106	1.4	11.5	0.7	4.8
Attewan2	60	30	30	0.5	45	0.8	11.5	0.3	2.0
Evanston	4	1170	150	10	290	100.0	100.0	100.0	100.0
Evanston	8	360	65	31	250	30.8	43.3	310.0	86.2
Evanston	15	34	30	1	77	2.9	20.0	10.0	26.6
Evanston	30	31	22	0.5	74	2.6	14.7	5.0	25.5
Evanston	45	35	37	1	85	3.0	24.7	10.0	29.3
Evanston	60	32	33	0.5	67	2.7	22.0	5.0	23.1

**APPENDIX B.**

**TOTAL SOIL ARSENIC, CADMIUM, AND LEAD  
FOR THE SNELLMAN FIELD**

## LABORATORY REPORT

PAGE : 1

To : Hydrometrics  
Address : Attn: Pete Test  
2727 Airport Road  
Helena, MT 59601

Lab No. : 92-43400  
Date : 10/27/92

SOIL ANALYSIS REPORT

Sample Pt Name : CS-200X-3000Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
0-6, EPA Tag #H-00-913

LABORATORY DATA:

Total Arsenic-----	(ug/g) -----	11
Total Cadmium-----	(ug/g) -----	≤1
Total Lead-----	(ug/g) -----	17

Analysis done by EPA Method 3050.

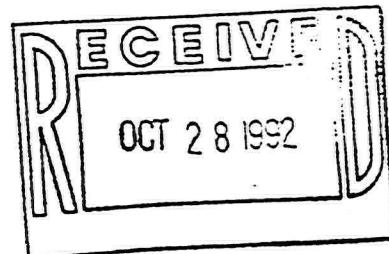
cc:

Replacement Soil Requirements

Lead < 50

As < 30

Cd < 5





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FAX (406) 252-6069 • 1-800-735-4489

## LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 00-43400  
Address : Attn: Pete Test Date : 10/27/92  
2727 Airport Road  
Helena, MT 59601

SOIL ANALYSIS REPORT

Sample Pt Name : CS-200X-3000Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
0-6, EPA Tag #H-00-913  
Duplicate Analysis

LABORATORY DATA:

Total Arsenic-----	(ug/g) -----	12
Total Cadmium-----	(ug/g) -----	<1
Total Lead-----	(ug/g) -----	17

Analysis done by EPA Method 3050.

cc:



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## LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 92-43401  
Address : Attn: Pete Test Date : 10/27/92  
2727 Airport Road  
Helena, MT 59601

## SOIL ANALYSIS REPORT

Sample Pt Name : CS-200X-3000Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
6-12, EPA Tag #H-00-910

LABORATORY DATA:

Total Arsenic-----	(ug/g) -----	10
Total Cadmium-----	(ug/g) -----	<1
Total Lead-----	(ug/g) -----	7

Analysis done by EPA Method 3050.

cc:



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## LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 92-43402  
Address : Attn: Pete Test Date : 10/27/92  
2727 Airport Road  
Helena, MT 59601

SOIL ANALYSIS REPORT

Sample Pt Name : CS-400X-3600Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
0-6, EPA Tag #H-00-911

LABORATORY DATA:

Total Arsenic-----	(ug/g) -----	10
Total Cadmium-----	(ug/g) -----	<1
Total Lead-----	(ug/g) -----	18

Analysis done by EPA Method 3050.

cc:



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### LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 92-43403  
Address : Attn: Pete Test Date : 10/27/92  
2727 Airport Road  
Helena, MT 59601

#### SOIL ANALYSIS REPORT

Sample Pt Name : CS-400X-3600Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
6-12, EPA Tag #H-00-912

#### LABORATORY DATA:

Total Arsenic-----	(ug/g)-----	17
Total Cadmium-----	(ug/g)-----	2
Total Lead-----	(ug/g)-----	39

Analysis done by EPA Method 3050.

cc:



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## LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 92-43404  
Address : Attn: Pete Test Date : 10/27/92  
2727 Airport Road  
Helena, MT 59601

SOIL ANALYSIS REPORT

Sample Pt Name : CS-800X-2000Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
0-6, EPA Tag #H-00-904

LABORATORY DATA:

Total Arsenic-----	(ug/g)-----	15
Total Cadmium-----	(ug/g)-----	<1
Total Lead-----	(ug/g)-----	25

Analysis done by EPA Method 3050.

cc:



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## LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 92-43405  
Address : Attn: Pete Test Date : 10/27/92  
2727 Airport Road  
Helena, MT 59601

SOIL ANALYSIS REPORT

Sample Pt Name : CS-800X-2000Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
6-12, EPA Tag #H-00-905

LABORATORY DATA:

Total Arsenic-----	(ug/g)-----	17
Total Cadmium-----	(ug/g)-----	1
Total Lead-----	(ug/g)-----	37

Analysis done by EPA Method 3050.

cc:



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## LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 92-43406  
Address : Attn: Pete Test Date : 10/27/92  
2727 Airport Road  
Helena, MT 59601

## SOIL ANALYSIS REPORT

Sample Pt Name : CS-1000X-200Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
0-6, EPA Tag #H-00-906

LABORATORY DATA:

Total Arsenic-----	(ug/g) -----	14
Total Cadmium-----	(ug/g) -----	1
Total Lead-----	(ug/g) -----	35

Analysis done by EPA Method 3050.

cc:



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FAX (406) 252-6069 • 1-800-735-4469

## LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 92-43407  
Address : Attn: Pete Test  
2727 Airport Road  
Helena, MT 59601 Date : 10/27/92

SOIL ANALYSIS REPORT

Sample Pt Name : CS-1000X-200Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
6-12, EPA Tag #H-00-907

LABORATORY DATA:

Total Arsenic-----	(ug/g) -----	15
Total Cadmium-----	(ug/g) -----	<1
Total Lead-----	(ug/g) -----	25

Analysis done by EPA Method 3050.

cc:



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FAX (406) 252-6369 • 1-800-735-4489

## LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 92-43408  
Address : Attn: Pete Test Date : 10/27/92  
2727 Airport Road  
Helena, MT 59601

## SOIL ANALYSIS REPORT

Sample Pt Name : CS-1200X-1800Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
0-6, EPA Tag #H-00-908

LABORATORY DATA:

Total Arsenic-----	(ug/g)-----	14
Total Cadmium-----	(ug/g)-----	<1
Total Lead-----	(ug/g)-----	22

Analysis done by EPA Method 3050.

cc:



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### LABORATORY REPORT

PAGE : 1

To : Hydrometrics Lab No. : 92-43409  
Address : Attn: Pete Test  
2727 Airport Road  
Helena, MT 59601 Date : 10/27/92

### SOIL ANALYSIS REPORT

Sample Pt Name : CS-1200X-1800Y  
Sample Date : 10/ 7/92  
Sample Received : 10/16/92  
ASEH01, AEH Residential Soils  
6-12, EPA Tag #H-00-909

### LABORATORY DATA:

Total Arsenic-----	(ug/g)-----	21
Total Cadmium-----	(ug/g)-----	1
Total Lead-----	(ug/g)-----	23

Analysis done by EPA Method 3050.

cc:

## **APPENDIX C.**

**DETAILED HELP MODEL INPUT AND OUTPUT FOR  
EXISTING CONDITIONS AND SOIL CAP SCENARIOS**

\*\*\*\*\*  
\*\*\*\*\*

East Helena Focused FS  
HELP Model Output for Attewan Series / No Cap  
March 18, 1993

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\*\*\*\*\*

LAYER 1

-----

VERTICAL PERCOLATION LAYER

THICKNESS	=	4.00 INCHES
POROSITY	=	0.4630 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1700 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000370000023 CM/SEC

LAYER 2

-----

VERTICAL PERCOLATION LAYER

THICKNESS	=	4.00 INCHES
POROSITY	=	0.4640 VOL/VOL
FIELD CAPACITY	=	0.3100 VOL/VOL
WILTING POINT	=	0.1870 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2500 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000064000000 CM/SEC

LAYER 3

-----

VERTICAL PERCOLATION LAYER

THICKNESS	=	7.00 INCHES
POROSITY	=	0.4630 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1700 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000370000023 CM/SEC

LAYER 4

-----  
VERTICAL PERCOLATION LAYER  
THICKNESS = 15.00 INCHES  
POROSITY = 0.4530 VOL/VOL  
FIELD CAPACITY = 0.1900 VOL/VOL  
WILTING POINT = 0.0850 VOL/VOL  
INITIAL SOIL WATER CONTENT = 0.0850 VOL/VOL  
SATURATED HYDRAULIC CONDUCTIVITY = 0.000719900010 CM/SEC

LAYER 5

-----  
VERTICAL PERCOLATION LAYER  
THICKNESS = 30.00 INCHES  
POROSITY = 0.4370 VOL/VOL  
FIELD CAPACITY = 0.0620 VOL/VOL  
WILTING POINT = 0.0240 VOL/VOL  
INITIAL SOIL WATER CONTENT = 0.0240 VOL/VOL  
SATURATED HYDRAULIC CONDUCTIVITY = 0.005799999926 CM/SEC

LAYER 6

-----  
VERTICAL PERCOLATION LAYER  
THICKNESS = 156.00 INCHES  
POROSITY = 0.4370 VOL/VOL  
FIELD CAPACITY = 0.1050 VOL/VOL  
WILTING POINT = 0.0470 VOL/VOL  
INITIAL SOIL WATER CONTENT = 0.0470 VOL/VOL  
SATURATED HYDRAULIC CONDUCTIVITY = 0.000169999999 CM/SEC

GENERAL SIMULATION DATA

-----  
SCS RUNOFF CURVE NUMBER = 80.00  
TOTAL AREA OF COVER = 5401440. SQ FT  
EVAPORATIVE ZONE DEPTH = 28.00 INCHES  
UPPER LIMIT VEG. STORAGE = 12.8380 INCHES  
INITIAL VEG. STORAGE = 3.9750 INCHES  
INITIAL SNOW WATER CONTENT = 0.0000 INCHES  
INITIAL TOTAL WATER STORAGE IN  
SOIL AND WASTE LAYERS = 12.1970 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

## CLIMATOLOGICAL DATA

**USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND  
SOLAR RADIATION FOR HELENA MONTANA**

MAXIMUM LEAF AREA INDEX = 2.00  
START OF GROWING SEASON (JULIAN DATE) = 169  
END OF GROWING SEASON (JULIAN DATE) = 244

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-----	-----	-----	-----	-----	-----
20.10	25.10	32.80	43.40	52.10	60.00
68.10	66.30	55.60	45.40	32.40	23.40

ANNUAL TOTALS FOR YEAR		72	
	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.23	3704490.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.580	3861975.	104.25
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.350	-157487.	-4.25
SOIL WATER AT START OF YEAR	12.20	5490113.	
SOIL WATER AT END OF YEAR	11.85	5332626.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

ANNUAL TOTALS FOR YEAR 73

( INCHES )	( CU. FT. )	PERCENT
------------	-------------	---------

PRECIPITATION	6.27	2822252.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	6.014	2706824.	95.91
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.256	115427.	4.09
SOIL WATER AT START OF YEAR	11.85	5332626.	
SOIL WATER AT END OF YEAR	11.64	5237779.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.47	210274.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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#### ANNUAL TOTALS FOR YEAR 74

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.46	4708256.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.056	4976689.	105.70
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.596	-268436.	-5.70
SOIL WATER AT START OF YEAR	11.64	5237779.	
SOIL WATER AT END OF YEAR	11.51	5179618.	
SNOW WATER AT START OF YEAR	0.47	210274.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	3.	0.00

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#### ANNUAL TOTALS FOR YEAR 75

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	20.96	9434519.	100.00
RUNOFF	0.002	894.	0.01
EVAPOTRANSPIRATION	20.381	9173730.	97.24
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.577	259889.	2.75
SOIL WATER AT START OF YEAR	11.51	5179618.	
SOIL WATER AT END OF YEAR	12.08	5437970.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	1536.	
ANNUAL WATER BUDGET BALANCE	0.00	6.	0.00

\*\*\*\*\*

\*\*\*\*\*

#### ANNUAL TOTALS FOR YEAR 76

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.07	4532710.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.770	4847798.	106.95
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.700	-315090.	-6.95
SOIL WATER AT START OF YEAR	12.08	5437970.	
SOIL WATER AT END OF YEAR	11.37	5118313.	
SNOW WATER AT START OF YEAR	0.00	1536.	
SNOW WATER AT END OF YEAR	0.01	6104.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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## ANNUAL TOTALS FOR YEAR 77

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.34	5104364.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.019	4509781.	88.35
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	1.321	594579.	11.65
SOIL WATER AT START OF YEAR	11.37	5118313.	
SOIL WATER AT END OF YEAR	12.28	5529377.	
SNOW WATER AT START OF YEAR	0.01	6104.	
SNOW WATER AT END OF YEAR	0.42	189619.	
ANNUAL WATER BUDGET BALANCE	0.00	3.	0.00

\*\*\*\*\*

## ANNUAL TOTALS FOR YEAR 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.97	4937818.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.010	4955607.	100.36
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.040	-17792.	-0.36
SOIL WATER AT START OF YEAR	12.28	5529377.	
SOIL WATER AT END OF YEAR	12.60	5669405.	
SNOW WATER AT START OF YEAR	0.42	189619.	
SNOW WATER AT END OF YEAR	0.07	31799.	
ANNUAL WATER BUDGET BALANCE	0.00	3.	0.00

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\*\*\*\*\*  
ANNUAL TOTALS FOR YEAR 79

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.39	4676748.	100.00
RUNOFF	0.034	15322.	0.33
EVAPOTRANSPIRATION	11.336	5102664.	109.11
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.980	-441239.	-9.43
SOIL WATER AT START OF YEAR	12.60	5669405.	
SOIL WATER AT END OF YEAR	11.67	5254533.	
SNOW WATER AT START OF YEAR	0.07	31799.	
SNOW WATER AT END OF YEAR	0.01	5432.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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\*\*\*\*\*  
ANNUAL TOTALS FOR YEAR 80

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	17.06	7679048.	100.00
RUNOFF	0.015	6712.	0.09
EVAPOTRANSPIRATION	16.197	7290412.	94.94
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.848	381924.	4.97
SOIL WATER AT START OF YEAR	11.67	5254533.	
SOIL WATER AT END OF YEAR	12.53	5641889.	
SNOW WATER AT START OF YEAR	0.01	5432.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	-1.	0.00

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ANNUAL TOTALS FOR YEAR 81

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	13.83	6225161.	100.00
RUNOFF	0.213	95792.	1.54
EVAPOTRANSPIRATION	13.916	6264033.	100.62
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.299	-134667.	-2.16
SOIL WATER AT START OF YEAR	12.53	5641889.	
SOIL WATER AT END OF YEAR	12.21	5496314.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.02	10909.	
ANNUAL WATER BUDGET BALANCE	0.00	3.	0.00

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ANNUAL TOTALS FOR YEAR 82

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	14.01	6306183.	100.00
RUNOFF	0.013	5735.	0.09
EVAPOTRANSPIRATION	13.449	6053733.	96.00
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.548	246712.	3.91
SOIL WATER AT START OF YEAR	12.21	5496314.	
SOIL WATER AT END OF YEAR	12.78	5753934.	
SNOW WATER AT START OF YEAR	0.02	10909.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

\*\*\*\*\*

\*\*\*\*\*  
ANNUAL TOTALS FOR YEAR 83

	( INCHES )	( CU. FT. )	PERCENT
PRECIPITATION	14.03	6315186.	100.00
RUNOFF	0.038	16951.	0.27
EVAPOTRANSPIRATION	14.342	6455428.	102.22
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.349	-157199.	-2.49
SOIL WATER AT START OF YEAR	12.78	5753934.	
SOIL WATER AT END OF YEAR	12.31	5540403.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.13	56332.	
ANNUAL WATER BUDGET BALANCE	0.00	6.	0.00

\*\*\*\*\*

\*\*\*\*\*  
ANNUAL TOTALS FOR YEAR 84

	( INCHES )	( CU. FT. )	PERCENT
PRECIPITATION	9.00	4051081.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.003	3602236.	88.92
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.997	448843.	11.08
SOIL WATER AT START OF YEAR	12.31	5540403.	
SOIL WATER AT END OF YEAR	13.27	5973456.	
SNOW WATER AT START OF YEAR	0.13	56332.	
SNOW WATER AT END OF YEAR	0.16	72122.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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ANNUAL TOTALS FOR YEAR 85

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.95	4028576.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	9.664	4349920.	107.98
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.714	-321348.	-7.98
SOIL WATER AT START OF YEAR	13.27	5973456.	
SOIL WATER AT END OF YEAR	12.72	5724230.	
SNOW WATER AT START OF YEAR	0.16	72122.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	4.	0.00

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ANNUAL TOTALS FOR YEAR 86

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	12.10	5446454.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	12.534	5641760.	103.59
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.434	-195307.	-3.59
SOIL WATER AT START OF YEAR	12.72	5724230.	
SOIL WATER AT END OF YEAR	12.28	5528922.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	

ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00
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ANNUAL TOTALS FOR YEAR 87

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.04	4519207.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.143	4565595.	101.03
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.103	-46389.	-1.03
SOIL WATER AT START OF YEAR	12.28	5528922.	
SOIL WATER AT END OF YEAR	12.17	5477357.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.01	5176.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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ANNUAL TOTALS FOR YEAR 88

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.03	4514705.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	9.199	4140764.	91.72
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.831	373940.	8.28
SOIL WATER AT START OF YEAR	12.17	5477357.	
SOIL WATER AT END OF YEAR	12.96	5835243.	
SNOW WATER AT START OF YEAR	0.01	5176.	

SNOW WATER AT END OF YEAR	0.05	21231.
ANNUAL WATER BUDGET BALANCE	0.00	0. 0.00

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ANNUAL TOTALS FOR YEAR 89

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	12.51	5631003.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	13.515	6083496.	108.04
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-1.005	-452494.	-8.04
SOIL WATER AT START OF YEAR	12.96	5835243.	
SOIL WATER AT END OF YEAR	12.01	5403980.	
SNOW WATER AT START OF YEAR	0.05	21231.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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ANNUAL TOTALS FOR YEAR 90

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.43	3794512.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.189	3686187.	97.15
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.241	108322.	2.85
SOIL WATER AT START OF YEAR	12.01	5403980.	
SOIL WATER AT END OF YEAR	11.87	5341067.	

SNOW WATER AT START OF YEAR	0.00	0.
SNOW WATER AT END OF YEAR	0.38	171235.
ANNUAL WATER BUDGET BALANCE	0.00	3. 0.00

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ANNUAL TOTALS FOR YEAR 91

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.92	5365431.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.057	4976810.	92.76
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.863	388620.	7.24
SOIL WATER AT START OF YEAR	11.87	5341067.	
SOIL WATER AT END OF YEAR	13.11	5900922.	
SNOW WATER AT START OF YEAR	0.38	171235.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	1. 0.00	

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 72 THROUGH 91

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

PRECIPITATION

TOTALS	0.54	0.41	0.76	0.93	1.73	1.71
	1.25	1.36	1.24	0.57	0.49	0.54
STD. DEVIATIONS	0.41	0.33	0.43	0.69	1.32	0.99
	1.20	1.10	0.88	0.59	0.30	0.32

**RUNOFF**

TOTALS	0.000	0.000	0.000	0.000	0.011	0.002
	0.000	0.002	0.001	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.048	0.008
	0.000	0.008	0.003	0.000	0.000	0.000

**EVAPOTRANSPIRATION**

TOTALS	0.392	0.562	0.904	0.849	1.470	1.749
	1.812	1.290	1.121	0.617	0.377	0.324
STD. DEVIATIONS	0.158	0.289	0.500	0.587	0.946	0.908
	1.073	1.171	0.775	0.436	0.179	0.141

**PERCOLATION FROM LAYER 6**

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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**AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 72 THROUGH 91**

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.53 ( 3.319)	5189885.	100.00
RUNOFF	0.016 ( 0.048)	7070.	0.14
EVAPOTRANSPIRATION	11.469 ( 3.240)	5162272.	99.47
PERCOLATION FROM LAYER 6	0.0000 ( 0.0000)	0.	0.00
CHANGE IN WATER STORAGE	0.046 ( 0.706)	20540.	0.40

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**PEAK DAILY VALUES FOR YEARS 72 THROUGH 91**

	(INCHES)	(CU. FT.)
PRECIPITATION	1.93	868731.6
RUNOFF	0.181	81429.0
PERCOLATION FROM LAYER 6	0.0000	0.0

SNOW WATER 1.04 467036.4

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2602

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1115

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FINAL WATER STORAGE AT END OF YEAR 91

LAYER	(INCHES)	(VOL/VOL)
1	0.99	0.2487
2	1.15	0.2880
3	1.10	0.1568
4	1.37	0.0914
5	1.16	0.0386
6	7.33	0.0470
SNOW WATER	0.00	

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East Helena Focused FS  
HELP Model Output for Nippt Series / No Cap  
March 19, 1993

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LAYER 1

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VERTICAL PERCOLATION LAYER

THICKNESS	=	4.00 INCHES
POROSITY	=	0.4630 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1700 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000370000023 CM/SEC

LAYER 2

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VERTICAL PERCOLATION LAYER

THICKNESS	=	4.00 INCHES
POROSITY	=	0.4640 VOL/VOL
FIELD CAPACITY	=	0.3100 VOL/VOL
WILTING POINT	=	0.1870 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2500 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000064000000 CM/SEC

LAYER 3

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VERTICAL PERCOLATION LAYER

THICKNESS	=	7.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0750 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001700000023 CM/SEC

LAYER 4

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VERTICAL PERCOLATION LAYER

THICKNESS	=	45.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0620 VOL/VOL
WILTING POINT	=	0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0240 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.005799999926 CM/SEC

LAYER 5

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VERTICAL PERCOLATION LAYER

THICKNESS	=	156.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0470 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000169999999 CM/SEC

GENERAL SIMULATION DATA

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SCS RUNOFF CURVE NUMBER	=	80.00
TOTAL AREA OF COVER	=	5401440. SQ FT
EVAPORATIVE ZONE DEPTH	=	28.00 INCHES
UPPER LIMIT VEG. STORAGE	=	12.4480 INCHES
INITIAL VEG. STORAGE	=	2.5170 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	10.6170 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

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USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND  
SOLAR RADIATION FOR                   HELENA                   MONTANA

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	169
END OF GROWING SEASON (JULIAN DATE)	=	244

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
20.10	25.10	32.80	43.40	52.10	60.00
68.10	66.30	55.60	45.40	32.40	23.40

ANNUAL TOTALS FOR YEAR 72

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.23	3704490.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.346	3756563.	101.41
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.116	-52077.	-1.41
SOIL WATER AT START OF YEAR	10.62	4778924.	
SOIL WATER AT END OF YEAR	10.50	4726847.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	4.	0.00

ANNUAL TOTALS FOR YEAR 73

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	6.27	2822252.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	5.840	2628595.	93.14
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.430	193657.	6.86
SOIL WATER AT START OF YEAR	10.50	4726847.	
SOIL WATER AT END OF YEAR	10.46	4710229.	

SNOW WATER AT START OF YEAR	0.00	0.
SNOW WATER AT END OF YEAR	0.47	210274.
ANNUAL WATER BUDGET BALANCE	0.00	0. 0.00

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ANNUAL TOTALS FOR YEAR 74

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.46	4708256.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.216	5048443.	107.23
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.756	-340187.	-7.23
SOIL WATER AT START OF YEAR	10.46	4710229.	
SOIL WATER AT END OF YEAR	10.18	4580317.	
SNOW WATER AT START OF YEAR	0.47	210274.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	-1.	0.00

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ANNUAL TOTALS FOR YEAR 75

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	20.96	9434519.	100.00
RUNOFF	0.002	1011.	0.01
EVAPOTRANSPIRATION	20.503	9228901.	97.82
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.455	204605.	2.17
SOIL WATER AT START OF YEAR	10.18	4580317.	

SOIL WATER AT END OF YEAR	10.63	4783385.
SNOW WATER AT START OF YEAR	0.00	0.
SNOW WATER AT END OF YEAR	0.00	1536.
ANNUAL WATER BUDGET BALANCE	0.00	3. 0.00

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ANNUAL TOTALS FOR YEAR 76

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.07	4532710.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.678	4806464.	106.04
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.608	-273753.	-6.04
SOIL WATER AT START OF YEAR	10.63	4783385.	
SOIL WATER AT END OF YEAR	10.01	4505064.	
SNOW WATER AT START OF YEAR	0.00	1536.	
SNOW WATER AT END OF YEAR	0.01	6104.	
ANNUAL WATER BUDGET BALANCE	0.00	-1.	0.00

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ANNUAL TOTALS FOR YEAR 77

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.34	5104364.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.043	4520578.	88.56
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	1.297	583782.	11.44

SOIL WATER AT START OF YEAR	10.01	4505064.
SOIL WATER AT END OF YEAR	10.90	4905331.
SNOW WATER AT START OF YEAR	0.01	6104.
SNOW WATER AT END OF YEAR	0.42	189619.
ANNUAL WATER BUDGET BALANCE	0.00	4. 0.00

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ANNUAL TOTALS FOR YEAR 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.97	4937818.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.021	4960642.	100.46
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.051	-22826.	-0.46
SOIL WATER AT START OF YEAR	10.90	4905331.	
SOIL WATER AT END OF YEAR	11.20	5040325.	
SNOW WATER AT START OF YEAR	0.42	189619.	
SNOW WATER AT END OF YEAR	0.07	31799.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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ANNUAL TOTALS FOR YEAR 79

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.39	4676748.	100.00
RUNOFF	0.037	16828.	0.36
EVAPOTRANSPIRATION	11.287	5080365.	108.63
PERCOLATION FROM LAYER 5	0.0000	0.	0.00

CHANGE IN WATER STORAGE	-0.934	-420448.	-8.99
SOIL WATER AT START OF YEAR	11.20	5040325.	
SOIL WATER AT END OF YEAR	10.32	4646244.	
SNOW WATER AT START OF YEAR	0.07	31799.	
SNOW WATER AT END OF YEAR	0.01	5432.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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ANNUAL TOTALS FOR YEAR 80

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	17.06	7679048.	100.00
RUNOFF	0.015	6847.	0.09
EVAPOTRANSPIRATION	16.962	7634832.	99.42
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.083	37364.	0.49
SOIL WATER AT START OF YEAR	10.32	4646244.	
SOIL WATER AT END OF YEAR	10.42	4689040.	
SNOW WATER AT START OF YEAR	0.01	5432.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	4.	0.00

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ANNUAL TOTALS FOR YEAR 81

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	13.83	6225161.	100.00
RUNOFF	0.167	75176.	1.21
EVAPOTRANSPIRATION	12.761	5743899.	92.27

PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.902	406086.	6.52
SOIL WATER AT START OF YEAR	10.42	4689040.	
SOIL WATER AT END OF YEAR	11.30	5084217.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.02	10909.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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#### ANNUAL TOTALS FOR YEAR 82

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	14.01	6306183.	100.00
RUNOFF	0.009	4213.	0.07
EVAPOTRANSPIRATION	13.596	6119768.	97.04
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.405	182202.	2.89
SOIL WATER AT START OF YEAR	11.30	5084217.	
SOIL WATER AT END OF YEAR	11.72	5277327.	
SNOW WATER AT START OF YEAR	0.02	10909.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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#### ANNUAL TOTALS FOR YEAR 83

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	14.03	6315186.	100.00
RUNOFF	0.037	16525.	0.26

EVAPOTRANSPIRATION	14.301	6437339.	101.93
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.308	-138679.	-2.20
SOIL WATER AT START OF YEAR	11.72	5277327.	
SOIL WATER AT END OF YEAR	11.29	5082394.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.12	56254.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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#### ANNUAL TOTALS FOR YEAR 84

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	9.00	4051081.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.344	3755814.	92.71
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.656	295266.	7.29
SOIL WATER AT START OF YEAR	11.29	5082394.	
SOIL WATER AT END OF YEAR	11.91	5361792.	
SNOW WATER AT START OF YEAR	0.12	56254.	
SNOW WATER AT END OF YEAR	0.16	72122.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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#### ANNUAL TOTALS FOR YEAR 85

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.95	4028576.	100.00

RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	9.432	4245501.	105.38
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.482	-216925.	-5.38
SOIL WATER AT START OF YEAR	11.91	5361792.	
SOIL WATER AT END OF YEAR	11.59	5216989.	
SNOW WATER AT START OF YEAR	0.16	72122.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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#### ANNUAL TOTALS FOR YEAR 86

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	12.10	5446454.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	12.401	5582010.	102.49
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.301	-135555.	-2.49
SOIL WATER AT START OF YEAR	11.59	5216989.	
SOIL WATER AT END OF YEAR	11.29	5081434.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	-1.	0.00

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#### ANNUAL TOTALS FOR YEAR 87

(INCHES)	(CU. FT.)	PERCENT
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PRECIPITATION	10.04	4519207.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.060	4528191.	100.20
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.020	-8983.	-0.20
SOIL WATER AT START OF YEAR	11.29	5081434.	
SOIL WATER AT END OF YEAR	11.26	5067274.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.01	5176.	
ANNUAL WATER BUDGET BALANCE	0.00	-1.	0.00

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#### ANNUAL TOTALS FOR YEAR 88

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.03	4514705.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	9.908	4459971.	98.79
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.122	54733.	1.21
SOIL WATER AT START OF YEAR	11.26	5067274.	
SOIL WATER AT END OF YEAR	11.34	5105953.	
SNOW WATER AT START OF YEAR	0.01	5176.	
SNOW WATER AT END OF YEAR	0.05	21231.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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#### ANNUAL TOTALS FOR YEAR 89

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	12.51	5631003.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	12.909	5810628.	103.19
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.399	-179625.	-3.19
SOIL WATER AT START OF YEAR	11.34	5105953.	
SOIL WATER AT END OF YEAR	10.99	4947559.	
SNOW WATER AT START OF YEAR	0.05	21231.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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#### ANNUAL TOTALS FOR YEAR 90

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.43	3794512.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.196	3689226.	97.23
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.234	105285.	2.77
SOIL WATER AT START OF YEAR	10.99	4947559.	
SOIL WATER AT END OF YEAR	10.85	4881609.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.38	171235.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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## ANNUAL TOTALS FOR YEAR 91

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.92	5365431.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.022	4961051.	92.46
PERCOLATION FROM LAYER 5	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.898	404381.	7.54
SOIL WATER AT START OF YEAR	10.85	4881609.	
SOIL WATER AT END OF YEAR	12.12	5457225.	
SNOW WATER AT START OF YEAR	0.38	171235.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	-1.	0.00

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## AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 72 THROUGH 91

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.54 1.25	0.41 1.36	0.76 1.24	0.93 0.57	1.73 0.49	1.71 0.54
STD. DEVIATIONS	0.41 1.20	0.33 1.10	0.43 0.88	0.69 0.59	1.32 0.30	0.99 0.32
RUNOFF						
TOTALS	0.000 0.000	0.000 0.002	0.000 0.001	0.000 0.000	0.008 0.000	0.002 0.000
STD. DEVIATIONS	0.000 0.000	0.000 0.008	0.000 0.003	0.000 0.000	0.037 0.000	0.008 0.000
EVAPOTRANSPIRATION						
TOTALS	0.389 1.731	0.553 1.214	0.868 1.194	0.887 0.616	1.505 0.392	1.782 0.311
STD. DEVIATIONS	0.147	0.302	0.508	0.600	0.924	0.839

1.083 1.193 0.801 0.433 0.197 0.132

PERCOLATION FROM LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 72 THROUGH 91

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.53 ( 3.319)	5189885.	100.00
RUNOFF	0.013 ( 0.038)	6030.	0.12
EVAPOTRANSPIRATION	11.441 ( 3.265)	5149939.	99.23
PERCOLATION FROM LAYER 5	0.0000 ( 0.0000)	0.	0.00
CHANGE IN WATER STORAGE	0.075 ( 0.592)	33915.	0.65

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PEAK DAILY VALUES FOR YEARS 72 THROUGH 91

	(INCHES)	(CU. FT.)
PRECIPITATION	1.93	868731.6
RUNOFF	0.152	68613.6
PERCOLATION FROM LAYER 5	0.0000	0.0
SNOW WATER	1.04	467036.4

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.1958

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0659

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FINAL WATER STORAGE AT END OF YEAR 91

LAYER	(INCHES)	(VOL/VOL)
1	0.99	0.2487
2	1.04	0.2591
3	0.77	0.1102
4	1.92	0.0427
5	7.40	0.0474
SNOW WATER	0.00	

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East Helena Focused FS  
HELP Model Output for Attewan Series / 12 inch Soil Cap  
March 19, 1993  
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LAYER 1

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VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4530 VOL/VOL
FIELD CAPACITY	=	0.1900 VOL/VOL
WILTING POINT	=	0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0850 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000719999953 CM/SEC

LAYER 2

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VERTICAL PERCOLATION LAYER

THICKNESS	=	4.00 INCHES
POROSITY	=	0.4630 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1700 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000370000023 CM/SEC

LAYER 3

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VERTICAL PERCOLATION LAYER

THICKNESS	=	4.00 INCHES
POROSITY	=	0.4640 VOL/VOL
FIELD CAPACITY	=	0.3100 VOL/VOL
WILTING POINT	=	0.1870 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2500 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000064000000 CM/SEC

LAYER 4

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VERTICAL PERCOLATION LAYER

THICKNESS	=	7.00 INCHES
POROSITY	=	0.4630 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1700 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000370000023 CM/SEC

LAYER 5

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VERTICAL PERCOLATION LAYER

THICKNESS	=	15.00 INCHES
POROSITY	=	0.4530 VOL/VOL
FIELD CAPACITY	=	0.1900 VOL/VOL
WILTING POINT	=	0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0850 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000719999953 CM/SEC

LAYER 6

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VERTICAL PERCOLATION LAYER

THICKNESS	=	30.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0620 VOL/VOL
WILTING POINT	=	0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0240 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.005799999926 CM/SEC

LAYER 7

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VERTICAL PERCOLATION LAYER

THICKNESS	=	156.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0470 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000169999999 CM/SEC

GENERAL SIMULATION DATA

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SCS RUNOFF CURVE NUMBER = 60.00  
TOTAL AREA OF COVER = 5401440. SQ FT  
EVAPORATIVE ZONE DEPTH = 28.00 INCHES  
UPPER LIMIT VEG. STORAGE = 12.8380 INCHES  
INITIAL VEG. STORAGE = 3.9750 INCHES  
INITIAL SNOW WATER CONTENT = 0.0000 INCHES  
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS = 13.2170 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

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USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR HELENA MONTANA

MAXIMUM LEAF AREA INDEX = 2.00  
START OF GROWING SEASON (JULIAN DATE) = 169  
END OF GROWING SEASON (JULIAN DATE) = 244

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
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20.10	25.10	32.80	43.40	52.10	60.00
68.10	66.30	55.60	45.40	32.40	23.40

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ANNUAL TOTALS FOR YEAR 72

	(INCHES)	(CU. FT.)	PERCENT
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PRECIPITATION	8.23	3704490.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.549	3847947.	103.87
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.319	-143460.	-3.87
SOIL WATER AT START OF YEAR	13.22	5949236.	
SOIL WATER AT END OF YEAR	12.90	5805776.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	

ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00
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ANNUAL TOTALS FOR YEAR 73

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	6.27	2822252.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	5.901	2656250.	94.12
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.369	166002.	5.88
SOIL WATER AT START OF YEAR	12.90	5805776.	
SOIL WATER AT END OF YEAR	12.80	5761504.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.47	210274.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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ANNUAL TOTALS FOR YEAR 74

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.46	4708256.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.171	5028267.	106.80
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.711	-320011.	-6.80
SOIL WATER AT START OF YEAR	12.80	5761504.	
SOIL WATER AT END OF YEAR	12.56	5651767.	
SNOW WATER AT START OF YEAR	0.47	210274.	

SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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ANNUAL TOTALS FOR YEAR 75

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	20.96	9434519.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	20.564	9256142.	98.11
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.396	178369.	1.89
SOIL WATER AT START OF YEAR	12.56	5651767.	
SOIL WATER AT END OF YEAR	12.95	5828600.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	1536.	
ANNUAL WATER BUDGET BALANCE	0.00	8.	0.00

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ANNUAL TOTALS FOR YEAR 76

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.07	4532710.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.610	4775954.	105.37
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.540	-243245.	-5.37
SOIL WATER AT START OF YEAR	12.95	5828600.	
SOIL WATER AT END OF YEAR	12.40	5580787.	

SNOW WATER AT START OF YEAR	0.00	1536.
SNOW WATER AT END OF YEAR	0.01	6104.
ANNUAL WATER BUDGET BALANCE	0.00	0. 0.00

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ANNUAL TOTALS FOR YEAR 77

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.34	5104364.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.034	4516635.	88.49
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	1.306	587724.	11.51
SOIL WATER AT START OF YEAR	12.40	5580787.	
SOIL WATER AT END OF YEAR	13.30	5984996.	
SNOW WATER AT START OF YEAR	0.01	6104.	
SNOW WATER AT END OF YEAR	0.42	189619.	
ANNUAL WATER BUDGET BALANCE	0.00	4.	0.00

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ANNUAL TOTALS FOR YEAR 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.97	4937818.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.998	4950259.	100.25
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.028	-12446.	-0.25
SOIL WATER AT START OF YEAR	13.30	5984996.	

SOIL WATER AT END OF YEAR	13.62	6130371.
SNOW WATER AT START OF YEAR	0.42	189619.
SNOW WATER AT END OF YEAR	0.07	31799.
ANNUAL WATER BUDGET BALANCE	0.00	4. 0.00

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#### ANNUAL TOTALS FOR YEAR 79

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.39	4676748.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.371	5118371.	109.44
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.981	-441622.	-9.44
SOIL WATER AT START OF YEAR	13.62	6130371.	
SOIL WATER AT END OF YEAR	12.70	5715115.	
SNOW WATER AT START OF YEAR	0.07	31799.	
SNOW WATER AT END OF YEAR	0.01	5432.	
ANNUAL WATER BUDGET BALANCE	0.00	-1.	0.00

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#### ANNUAL TOTALS FOR YEAR 80

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	17.06	7679048.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	16.347	7358163.	95.82
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.713	320886.	4.18

SOIL WATER AT START OF YEAR	12.70	5715115.
SOIL WATER AT END OF YEAR	13.42	6041434.
SNOW WATER AT START OF YEAR	0.01	5432.
SNOW WATER AT END OF YEAR	0.00	0.
ANNUAL WATER BUDGET BALANCE	0.00	-1. 0.00

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#### ANNUAL TOTALS FOR YEAR 81

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	13.83	6225161.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	14.106	6349581.	102.00
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.276	-124422.	-2.00
SOIL WATER AT START OF YEAR	13.42	6041434.	
SOIL WATER AT END OF YEAR	13.12	5906103.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.02	10909.	
ANNUAL WATER BUDGET BALANCE	0.00	3.	0.00

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#### ANNUAL TOTALS FOR YEAR 82

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	14.01	6306183.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	13.517	6084406.	96.48
PERCOLATION FROM LAYER 7	0.0000	0.	0.00

CHANGE IN WATER STORAGE	0.493	221774.	3.52
SOIL WATER AT START OF YEAR	13.12	5906103.	
SOIL WATER AT END OF YEAR	13.64	6138785.	
SNOW WATER AT START OF YEAR	0.02	10909.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	3.	0.00

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ANNUAL TOTALS FOR YEAR 83

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	14.03	6315186.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	14.332	6451071.	102.15
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.302	-135887.	-2.15
SOIL WATER AT START OF YEAR	13.64	6138785.	
SOIL WATER AT END OF YEAR	13.21	5946869.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.12	56030.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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ANNUAL TOTALS FOR YEAR 84

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	9.00	4051081.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	7.923	3566401.	88.04

PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	1.077	484678.	11.96
SOIL WATER AT START OF YEAR	13.21	5946869.	
SOIL WATER AT END OF YEAR	14.25	6415455.	
SNOW WATER AT START OF YEAR	0.12	56030.	
SNOW WATER AT END OF YEAR	0.16	72122.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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#### ANNUAL TOTALS FOR YEAR 85

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.95	4028576.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	9.433	4245847.	105.39
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.483	-217274.	-5.39
SOIL WATER AT START OF YEAR	14.25	6415455.	
SOIL WATER AT END OF YEAR	13.93	6270303.	
SNOW WATER AT START OF YEAR	0.16	72122.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	3.	0.00

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#### ANNUAL TOTALS FOR YEAR 86

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	12.10	5446454.	100.00
RUNOFF	0.000	0.	0.00

EVAPOTRANSPIRATION	12.845	5781916.	106.16
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.745	-335463.	-6.16
SOIL WATER AT START OF YEAR	13.93	6270303.	
SOIL WATER AT END OF YEAR	13.19	5934841.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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#### ANNUAL TOTALS FOR YEAR 87

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.04	4519207.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.138	4563456.	100.98
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.098	-44249.	-0.98
SOIL WATER AT START OF YEAR	13.19	5934841.	
SOIL WATER AT END OF YEAR	13.08	5885415.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.01	5176.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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#### ANNUAL TOTALS FOR YEAR 88

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.03	4514705.	100.00

RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	9.647	4342141.	96.18
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.383	172562.	3.82
SOIL WATER AT START OF YEAR	13.08	5885415.	
SOIL WATER AT END OF YEAR	13.42	6041923.	
SNOW WATER AT START OF YEAR	0.01	5176.	
SNOW WATER AT END OF YEAR	0.05	21231.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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#### ANNUAL TOTALS FOR YEAR 89

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	12.51	5631003.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	13.072	5884127.	104.50
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.562	-253126.	-4.50
SOIL WATER AT START OF YEAR	13.42	6041923.	
SOIL WATER AT END OF YEAR	12.91	5810027.	
SNOW WATER AT START OF YEAR	0.05	21231.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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#### ANNUAL TOTALS FOR YEAR 90

(INCHES)	(CU. FT.)	PERCENT
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PRECIPITATION	8.43	3794512.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.189	3686219.	97.15
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.241	108292.	2.85
SOIL WATER AT START OF YEAR	12.91	5810027.	
SOIL WATER AT END OF YEAR	12.77	5747084.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.38	171235.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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#### ANNUAL TOTALS FOR YEAR 91

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.92	5365431.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.061	4978935.	92.80
PERCOLATION FROM LAYER 7	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.859	386497.	7.20
SOIL WATER AT START OF YEAR	12.77	5747084.	
SOIL WATER AT END OF YEAR	14.01	6304816.	
SNOW WATER AT START OF YEAR	0.38	171235.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	-1.	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 72 THROUGH 91

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

PRECIPITATION

TOTALS	0.54	0.41	0.76	0.93	1.73	1.71
	1.25	1.36	1.24	0.57	0.49	0.54
STD. DEVIATIONS	0.41	0.33	0.43	0.69	1.32	0.99
	1.20	1.10	0.88	0.59	0.30	0.32

RUNOFF

TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	0.370	0.542	0.912	0.865	1.486	1.806
	1.780	1.259	1.158	0.614	0.378	0.322
STD. DEVIATIONS	0.139	0.293	0.479	0.596	0.988	0.908
	1.057	1.169	0.817	0.455	0.192	0.145

PERCOLATION FROM LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 72 THROUGH 91

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.53 ( 3.319)	5189885.	100.00
RUNOFF	0.000 ( 0.000)	0.	0.00
EVAPOTRANSPIRATION	11.491 ( 3.290)	5172104.	99.66
PERCOLATION FROM LAYER 7	0.0000 ( 0.0000)	0.	0.00
CHANGE IN WATER STORAGE	0.039 ( 0.647)	17779.	0.34

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PEAK DAILY VALUES FOR YEARS 72 THROUGH 91

	(INCHES)	(CU. FT.)
PRECIPITATION	1.93	868731.6
RUNOFF	0.000	0.0
PERCOLATION FROM LAYER 7	0.0000	0.0
SNOW WATER	1.04	467036.4
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2552	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1115	

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FINAL WATER STORAGE AT END OF YEAR 91

LAYER	(INCHES)	(VOL/VOL)
1	2.25	0.1875
2	0.55	0.1387
3	0.60	0.1498
4	0.86	0.1222
5	1.69	0.1125
6	0.73	0.0243
7	7.33	0.0470
SNOW WATER	0.00	

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East Helena Focused FS  
HELP Model Output for Nippt Series / 12 inch Soil Cap  
March 19, 1993  
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LAYER 1

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VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4530 VOL/VOL
FIELD CAPACITY	=	0.1900 VOL/VOL
WILTING POINT	=	0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0850 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000719999953 CM/SEC

LAYER 2

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VERTICAL PERCOLATION LAYER

THICKNESS	=	4.00 INCHES
POROSITY	=	0.4630 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1700 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000370000023 CM/SEC

LAYER 3

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VERTICAL PERCOLATION LAYER

THICKNESS	=	4.00 INCHES
POROSITY	=	0.4640 VOL/VOL
FIELD CAPACITY	=	0.3100 VOL/VOL
WILTING POINT	=	0.1870 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2500 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000064000000 CM/SEC

LAYER 4

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VERTICAL PERCOLATION LAYER

THICKNESS	=	7.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0750 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001700000023 CM/SEC

LAYER 5

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VERTICAL PERCOLATION LAYER

THICKNESS	=	45.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0620 VOL/VOL
WILTING POINT	=	0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0240 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.005799999926 CM/SEC

LAYER 6

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VERTICAL PERCOLATION LAYER

THICKNESS	=	156.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0470 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000169999999 CM/SEC

GENERAL SIMULATION DATA

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SCS RUNOFF CURVE NUMBER	=	60.00
TOTAL AREA OF COVER	=	5401440. SQ FT
EVAPORATIVE ZONE DEPTH	=	28.00 INCHES
UPPER LIMIT VEG. STORAGE	=	12.6400 INCHES
INITIAL VEG. STORAGE	=	3.2490 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	11.6370 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND  
SOLAR RADIATION FOR           HELENA                           MONTANA

MAXIMUM LEAF AREA INDEX   = 2.00  
START OF GROWING SEASON (JULIAN DATE)                       = 169  
END OF GROWING SEASON (JULIAN DATE)                        = 244

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
20.10	25.10	32.80	43.40	52.10	60.00
68.10	66.30	55.60	45.40	32.40	23.40

ANNUAL TOTALS FOR YEAR      72

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.23	3704490.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.360	3763051.	101.58
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.130	-58565.	-1.58
SOIL WATER AT START OF YEAR	11.64	5238046.	
SOIL WATER AT END OF YEAR	11.51	5179481.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	3.	0.00

ANNUAL TOTALS FOR YEAR      73

(INCHES)	(CU. FT.)	PERCENT
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PRECIPITATION	6.27	2822252.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	5.926	2667298.	94.51
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.344	154954.	5.49
SOIL WATER AT START OF YEAR	11.51	5179481.	
SOIL WATER AT END OF YEAR	11.38	5124161.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.47	210274.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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#### ANNUAL TOTALS FOR YEAR 74

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.46	4708256.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.141	5014856.	106.51
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.681	-306602.	-6.51
SOIL WATER AT START OF YEAR	11.38	5124161.	
SOIL WATER AT END OF YEAR	11.17	5027834.	
SNOW WATER AT START OF YEAR	0.47	210274.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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#### ANNUAL TOTALS FOR YEAR 75

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	20.96	9434519.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	20.587	9266644.	98.22
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.373	167869.	1.78
SOIL WATER AT START OF YEAR	11.17	5027834.	
SOIL WATER AT END OF YEAR	11.54	5194167.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	1536.	
ANNUAL WATER BUDGET BALANCE	0.00	7.	0.00

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#### ANNUAL TOTALS FOR YEAR 76

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.07	4532710.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.594	4768513.	105.20
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.524	-235803.	-5.20
SOIL WATER AT START OF YEAR	11.54	5194167.	
SOIL WATER AT END OF YEAR	11.01	4953795.	
SNOW WATER AT START OF YEAR	0.00	1536.	
SNOW WATER AT END OF YEAR	0.01	6104.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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## ANNUAL TOTALS FOR YEAR 77

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.34	5104364.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.039	4518569.	88.52
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	1.301	585793.	11.48
SOIL WATER AT START OF YEAR	11.01	4953795.	
SOIL WATER AT END OF YEAR	11.90	5356073.	
SNOW WATER AT START OF YEAR	0.01	6104.	
SNOW WATER AT END OF YEAR	0.42	189619.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

## ANNUAL TOTALS FOR YEAR 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.97	4937818.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.000	4951398.	100.28
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.030	-13582.	-0.28
SOIL WATER AT START OF YEAR	11.90	5356073.	
SOIL WATER AT END OF YEAR	12.22	5500312.	
SNOW WATER AT START OF YEAR	0.42	189619.	
SNOW WATER AT END OF YEAR	0.07	31799.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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ANNUAL TOTALS FOR YEAR 79

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.39	4676748.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.363	5114702.	109.36
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.973	-437954.	-9.36
SOIL WATER AT START OF YEAR	12.22	5500312.	
SOIL WATER AT END OF YEAR	11.31	5088725.	
SNOW WATER AT START OF YEAR	0.07	31799.	
SNOW WATER AT END OF YEAR	0.01	5432.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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ANNUAL TOTALS FOR YEAR 80

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	17.06	7679048.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	16.544	7446874.	96.98
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.516	232173.	3.02
SOIL WATER AT START OF YEAR	11.31	5088725.	
SOIL WATER AT END OF YEAR	11.83	5326329.	
SNOW WATER AT START OF YEAR	0.01	5432.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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ANNUAL TOTALS FOR YEAR 81

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	13.83	6225161.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	13.276	5975744.	95.99
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.554	249415.	4.01
SOIL WATER AT START OF YEAR	11.83	5326329.	
SOIL WATER AT END OF YEAR	12.36	5564836.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.02	10909.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

  
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ANNUAL TOTALS FOR YEAR 82

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	14.01	6306183.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	13.565	6105870.	96.82
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.445	200311.	3.18
SOIL WATER AT START OF YEAR	12.36	5564836.	
SOIL WATER AT END OF YEAR	12.83	5776056.	
SNOW WATER AT START OF YEAR	0.02	10909.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

  
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ANNUAL TOTALS FOR YEAR 83

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	14.03	6315186.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	14.334	6451887.	102.16
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.304	-136703.	-2.16
SOIL WATER AT START OF YEAR	12.83	5776056.	
SOIL WATER AT END OF YEAR	12.40	5583445.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.12	55908.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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ANNUAL TOTALS FOR YEAR 84

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	9.00	4051081.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	7.964	3584787.	88.49
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	1.036	466292.	11.51
SOIL WATER AT START OF YEAR	12.40	5583445.	
SOIL WATER AT END OF YEAR	13.40	6033523.	
SNOW WATER AT START OF YEAR	0.12	55908.	
SNOW WATER AT END OF YEAR	0.16	72122.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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ANNUAL TOTALS FOR YEAR 85

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.95	4028576.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	9.689	4361058.	108.25
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.739	-332484.	-8.25
SOIL WATER AT START OF YEAR	13.40	6033523.	
SOIL WATER AT END OF YEAR	12.83	5773161.	
SNOW WATER AT START OF YEAR	0.16	72122.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

  
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ANNUAL TOTALS FOR YEAR 86

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	12.10	5446454.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	12.543	5646042.	103.66
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.443	-199589.	-3.66
SOIL WATER AT START OF YEAR	12.83	5773161.	
SOIL WATER AT END OF YEAR	12.38	5573572.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	

ANNUAL WATER BUDGET BALANCE            0.00            1.            0.00

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ANNUAL TOTALS FOR YEAR        87

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.04	4519207.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	10.130	4559848.	100.90
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-0.090	-40642.	-0.90
SOIL WATER AT START OF YEAR	12.38	5573572.	
SOIL WATER AT END OF YEAR	12.28	5527753.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.01	5176.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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ANNUAL TOTALS FOR YEAR        88

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	10.03	4514705.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	9.215	4147739.	91.87
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.815	366964.	8.13
SOIL WATER AT START OF YEAR	12.28	5527753.	
SOIL WATER AT END OF YEAR	13.06	5878663.	
SNOW WATER AT START OF YEAR	0.01	5176.	

SNOW WATER AT END OF YEAR	0.05	21231.
ANNUAL WATER BUDGET BALANCE	0.00	1. 0.00

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ANNUAL TOTALS FOR YEAR 89

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	12.51	5631003.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	13.518	6084587.	108.06
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	-1.008	-453585.	-8.06
SOIL WATER AT START OF YEAR	13.06	5878663.	
SOIL WATER AT END OF YEAR	12.10	5446309.	
SNOW WATER AT START OF YEAR	0.05	21231.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	2.	0.00

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ANNUAL TOTALS FOR YEAR 90

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	8.43	3794512.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	8.190	3686335.	97.15
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.240	108175.	2.85
SOIL WATER AT START OF YEAR	12.10	5446309.	
SOIL WATER AT END OF YEAR	11.96	5383248.	

SNOW WATER AT START OF YEAR	0.00	0.
SNOW WATER AT END OF YEAR	0.38	171235.
ANNUAL WATER BUDGET BALANCE	0.00	2. 0.00

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#### ANNUAL TOTALS FOR YEAR 91

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.92	5365431.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.055	4976295.	92.75
PERCOLATION FROM LAYER 6	0.0000	0.	0.00
CHANGE IN WATER STORAGE	0.865	389137.	7.25
SOIL WATER AT START OF YEAR	11.96	5383248.	
SOIL WATER AT END OF YEAR	13.20	5943621.	
SNOW WATER AT START OF YEAR	0.38	171235.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	-1.	0.00

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#### AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 72 THROUGH 91

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.54 1.25	0.41 1.36	0.76 1.24	0.93 0.57	1.73 0.49	1.71 0.54
STD. DEVIATIONS	0.41 1.20	0.33 1.10	0.43 0.88	0.69 0.59	1.32 0.30	0.99 0.32

**RUNOFF**

TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

**EVAPOTRANSPIRATION**

TOTALS	0.400	0.570	0.868	0.808	1.557	1.748
	1.780	1.276	1.135	0.602	0.382	0.328
STD. DEVIATIONS	0.159	0.292	0.497	0.598	0.983	0.880
	1.038	1.190	0.802	0.442	0.191	0.154

**PERCOLATION FROM LAYER 6**

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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**AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 72 THROUGH 91**

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	11.53 ( 3.319)	5189885.	100.00
RUNOFF	0.000 ( 0.000)	0.	0.00
EVAPOTRANSPIRATION	11.452 ( 3.300)	5154605.	99.32
PERCOLATION FROM LAYER 6	0.0000 ( 0.0000)	0.	0.00
CHANGE IN WATER STORAGE	0.078 ( 0.677)	35279.	0.68

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**PEAK DAILY VALUES FOR YEARS 72 THROUGH 91**

	(INCHES)	(CU. FT.)
PRECIPITATION	1.93	868731.6
RUNOFF	0.000	0.0
PERCOLATION FROM LAYER 6	0.0000	0.0

SNOW WATER 1.04 467036.4

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2490

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0920

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FINAL WATER STORAGE AT END OF YEAR 91

LAYER	(INCHES)	(VOL/VOL)
1	2.25	0.1879
2	0.56	0.1392
3	0.53	0.1334
4	0.44	0.0635
5	2.06	0.0458
6	7.36	0.0472

SNOW WATER 0.00

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**APPENDIX D.**

**PREDICTIVE DATA FOR TOTAL SOIL ARSENIC, CADMIUM,  
LEAD AND ZINC CONCENTRATIONS AND DEPTH**

1992 EAST FIELD SOIL SAMPLES  
Evaluation Of Metals' Mobilities to 60"

Depth Inches	Lead %	U95 %	L95 %	Pb1000 mg/kg	Pb2000 mg/kg	Pb3000 mg/kg	Pb4000 mg/kg	Arsenic %	U95 %	L95 %	As100 mg/kg	As200 mg/kg	As300 mg/kg	As400 mg/kg	Zinc %	U95 %	L95 %	Zn1000 mg/kg	Zn2000 mg/kg	Zn3000 mg/kg
1																				
2	111.2	114	109	1112	2224	3335	4447	102.4	105	100	102	205	307	410	113.9	118	110	1139	2278	3418
3	58.3	61	56	583	1166	1749	2333	75.7	78	74	76	151	227	303	82.4	87	78	824	1648	2471
4	36.9	39	35	369	738	1107	1476	61.0	63	59	61	122	183	244	65.5	69	62	655	1309	1964
5	25.9	28	24	259	517	776	1035	51.8	54	50	52	103	155	207	54.8	59	51	548	1095	1643
6	19.3	21	17	193	387	580	774	45.1	47	43	45	90	135	180	47.3	51	44	473	947	1420
7	15.1	17	13	151	303	454	606	40.2	42	38	40	80	120	161	41.8	45	38	418	837	1255
8	12.2	14	10	122	245	367	490	36.3	38	35	36	73	109	145	37.6	41	34	376	752	1128
9	10.1	12	8	101	203	304	406	33.3	35	31	33	87	100	133	34.2	38	31	342	685	1027
10	8.6	11	7	86	172	257	343	30.8	33	29	31	62	92	123	31.5	35	28	315	629	944
11	7.4	9	5	74	147	221	295	28.6	31	27	29	57	86	115	29.2	33	25	292	583	875
12	6.4	9	4	64	128	193	257	26.8	29	25	27	54	81	107	27.2	31	23	272	544	818
13	5.7	8	3	57	113	170	226	25.3	27	23	25	51	76	101	25.5	30	21	255	510	765
14	5.0	7	3	50	100	151	201	23.9	26	22	24	48	72	96	24.0	28	20	240	481	721
15	4.5	7	2	45	90	135	180	22.7	25	20	23	45	68	91	22.8	27	18	228	455	683
16	4.1	7	1	41	81	122	182	21.7	24	19	22	43	65	87	21.6	26	17	216	432	648
17	3.7	7	1	37	74	111	148	20.7	23	18	21	41	62	83	20.6	26	16	206	412	618
18	3.4	6	0	34	67	101	135	19.8	23	17	20	40	59	79	18.7	25	14	187	393	590
19	3.1	6	-0	31	62	93	124	19.0	22	18	19	38	57	76	18.8	24	13	188	377	565
20	2.8	6	-1	28	57	85	114	18.3	21	15	18	37	55	73	18.1	24	12	181	362	542
21	2.6	6	-1	26	53	79	105	17.7	21	14	18	35	53	71	17.4	24	11	174	348	522
22	2.4	6	-1	24	49	73	98	17.1	20	14	17	34	51	68	16.8	23	10	168	335	503
23	2.3	6	-2	23	46	68	91	16.5	20	13	17	33	50	66	16.2	23	9	162	323	485
24	2.1	6	-2	21	43	64	85	16.0	20	12	16	32	48	64	15.6	23	8	156	313	469
25	2.0	6	-2	20	40	60	80	15.5	19	12	16	31	47	62	15.1	23	7	151	303	454
26	1.9	6	-3	19	38	56	75	15.1	19	11	15	30	45	60	14.7	23	7	147	293	440
27	1.8	7	-3	18	35	53	71	14.6	19	10	15	29	44	59	14.2	23	6	142	285	427
28	1.7	7	-3	17	33	50	67	14.2	19	10	14	28	43	57	13.8	23	5	138	276	415
29	1.6	7	-4	16	32	47	63	13.9	19	9	14	28	42	56	13.4	23	4	134	269	403
30	1.5	7	-4	15	30	45	60	13.5	18	9	14	27	41	54	13.1	23	3	131	262	392
31	1.4	7	-4	14	28	43	57	13.2	18	8	13	26	40	53	12.7	23	3	127	255	382
32	1.3	7	-5	13	27	40	54	12.9	18	8	13	26	39	52	12.4	23	2	124	248	373
33	1.3	7	-5	13	26	38	51	12.6	18	7	13	25	38	50	12.1	23	1	121	242	364
34	1.2	8	-5	12	24	37	49	12.3	18	7	12	25	37	49	11.8	23	1	118	237	355
35	1.2	8	-5	12	23	35	47	12.1	18	6	12	24	36	48	11.6	23	0	116	231	347
36	1.1	8	-6	11	22	34	45	11.8	18	6	12	24	35	47	11.3	23	-1	113	226	339
37	1.1	8	-6	11	21	32	43	11.6	18	5	12	23	35	48	11.1	23	-1	111	221	332
38	1.0	8	-6	10	21	31	41	11.3	18	5	11	23	34	45	10.8	24	-2	108	216	325
39	1.0	8	-6	10	20	30	39	11.1	18	4	11	22	33	44	10.6	24	-2	106	212	318
40	0.9	9	-7	9	19	28	38	10.9	18	4	11	22	33	44	10.4	24	-3	104	208	312
41	0.9	9	-7	9	18	27	36	10.7	18	4	11	21	32	43	10.2	24	-4	102	204	306
42	0.9	9	-7	9	17	26	35	10.5	18	3	11	21	32	42	10.0	24	-4	100	200	300
43	0.8	9	-8	8	17	25	34	10.3	18	3	10	21	31	41	9.8	24	-5	98	196	294
44	0.8	9	-8	8	16	24	32	10.2	18	2	10	20	30	41	9.6	25	-5	96	193	289
45	0.8	10	-8	8	16	23	31	10.0	18	2	10	20	30	40	9.5	25	-6	95	189	284
46	0.8	10	-8	8	15	23	30	9.8	18	2	10	20	29	39	9.3	25	-7	93	186	279
47	0.7	10	-9	7	15	22	29	9.7	18	1	10	19	29	39	9.1	25	-7	91	183	274
48	0.7	10	-9	7	14	21	28	9.5	18	1	10	19	29	38	9.0	26	-8	90	180	269
49	0.7	10	-9	7	14	21	27	9.4	18	1	9	19	28	38	8.8	26	-8	88	177	265
50	0.7	11	-9	7	13	20	26	9.2	18	0	9	18	28	37	8.7	26	-9	87	174	261
51	0.6	11	-10	6	13	19	26	9.1	18	-0	9	18	27	36	8.6	26	-9	86	171	257
52	0.6	11	-10	6	12	19	25	9.0	18	-0	8	18	27	36	8.4	27	-10	84	168	253
53	0.6	11	-10	6	12	18	24	8.8	18	-1	9	18	27	35	8.3	27	-10	83	166	249
54	0.6	11	-10	6	12	18	23	8.7	18	-1	9	17	26	35	8.2	27	-11	82	163	245
55	0.6	12	-11	6	11	17	23	8.6	19	-1	8	17	26	34	8.1	28	-11	81	161	242
56	0.6	12	-11	6	11	17	22	8.5	19	-2	8	17	25	34	7.9	28	-12	79	159	238
57	0.5	12	-11	5	11	16	22	8.4	19	-2	8	17	25	34	7.8	28	-12	78	157	235
58	0.5	12	-11	5	10	16	21	8.3	19	-2	8	17	25	33	7.7	28	-13	77	154	232
59	0.5	13	-12	5	10	15	20	8.2	19	-3	8	16	24	33	7.6	29	-13	76	152	228
60	0.5	13	-12	5	10	15	20	8.1	19	-3	8	16	24	32	7.5	29	-14	75	150	225